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John Hawkins, As an Acknowledgment of Unmerited Favours, humbly Dedicateth this *Manual of Arithmetick*.

To the READER.

Courteous Reader.

I Having the Happiness of an Intimate Acquaintance with Mr. *Cocker*, in his Life-time often sollicited him to remember his Promise to the World of Publishing his *Arithmetick*, but (for Reasons best known to himself) he refused it; and (after his Death) the Copy falling accidentally into my Hands, I thought it not convenient to smother a Work of so considerable a Moment, not questioning, but it might be as kindly accepted, as if it had been presented by his own Hand. The Method is familiar and easie, discovering as well the Theory as the Practice of that Necessary Art of Vulgar *Arithmetick*: And in this new Edition there are many remarkable Alterations for the Benefit of the Teacher or Learner, which I hope will be very acceptable to the World: I have also performed my Promise in Publishing the *Decimal Arithmetick*, which finds Encouragement to my Expectation, and the Booksellers too, I am.

Thine to serve thee,

John Hawkins.

A 3

Mr.

Mr. EDWARD COCKER's

PROEM or PREFACE.

BY the sacred Influence of Divine Providence, I have been Instrumental to the Benefit of many; by Virtue of those useful Arts, Writing and Engraving: And do now with the same wonted Alacrity cast this my Arithmetical Mite into the Publick Treasury beseeching the Almighty to grant the like Blessing to these as to my former Labours.

Seven Sciences supremely excellent,
Are the chief Stars in Wisdoms Firmament;
Whereof Arithmetick is one, whose Worth,
The Beams of Profit and Delight shine forth;
This crowns the rest; This makes Man's mind complete;
This Treats of Numbers & of This we treat.

I have been often desired by my intimate Friends to publish something on this subject, who in a pleasing Freedom have signified to me that

they

they expected it would be extraordinary. How far I have answered their Expectation, I know not; but this I know, that I have designed this Work not extraordinary, abstruse or profound, but have by all means possible within the Circumference of my Capacity, endeavoured to render it extraordinary useful to all those, whose Occasions shall induce them to make use of Numbers. If it be objected that the Books already published treating of Numbers, are innumerable, I Answer, that's but a small Wonder, since the Art is infinite. But that there should be so many excellent Tracts of Practical Arithmetick extant, and so little practised, is to me a greater Wonder; knowing that as Merchandise is the Life of the Weal-Publick; so Practical Arithmetick is the Soul of Merchandise. Therefore I do ingenuously profess, that in the Beginning of this Undertaking, the numerous Concerns of the Honoured Merchants first possessed my Consideration: And how far I have accommodated this Composure for their most worthy Service, let their own profitable Experience judge.

Secondly, For your Service, most excellent Professors, whose Understandings soar to the Sublimity of the Theory and Practice of this Noble Science, was this Arithmetical Tractate compiled; which you may please to employ as a

a Monitor

Monitor to instruct your young Tyro's, *and thereby take Occasion to reserve your precious Moments, which might be exhausted that Way, for your more important Affairs.*

Thirdly, For you, the ingenious Off-spring of happy Parents, who will willingly pay the full Price of Industry and Exercise for those Arts and choise Accomplishments which may contribute to the Felicity of your future State. For you I say, (ingenious Practitioners) was this Work composed, which may prove the Pleasure of your Youth, and the Glory of your Age.

Lastly, For you the pretended Numerists of this vapouring Age, who are more disingeniously witty to propound unnecessary Questions, than ingeniously judicious to resolve such as are necessary. For you was this Book composed and published, if you will deny your selves so much as to invert the streams of your Ingenuity, and by studiously conferring with the Notes, Names, Orders, Progress, Species, Properties, Proprieties, Proportions, Powers, Affections and Applications of Numbers delivered herein, become such Artists indeed, as you now only seem to be. This Arithmetick ingeniously observed, and diligently practised, will turn to good Account to all that shall be concerned in Accompts. All whose Rules are

grounded on Verity and delivered with Sincerity. The Examples are built up gradually from the ſmalleſt Conſideration to the greateſt. All the Problems or Propoſitions are well weighed, pertinent, and clear, and not one of them throughout the Tract taken upon Truſt; thereſore now,

Zoilus and *Momus* lie you down and dye,
For theſe Inventions your whole Force defy.

Edward Cocker.

BEING well Acquainted with the deceased Author, and finding him knowing and studious in the Mysteries of Numbers and Algebra, of which he had some choice Manuscripts, and a great Collection of Printed Authors in several Languages, I doubt not but he hath writ his Arithmetick suitable to his own Preface, and worthy Acceptation; which I thought to certifie on a Request to that Purpose made to him that wisheth thy Welfare, and the Progress of Arts.

JOHN COLLINS.

November 27th, 1677.

This MANUAL *of* ARITHMETICK, *is recommended to the World by Us whose Names are subscribed*, viz.

Mr. *John Collins* (Math.)	Mr. *William Mason*
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And generally Approved by all Ingenious Artists.

CHAP. I.

Notation of Numbers.

1. ARithmetick is an Art of Numbring, or Knowledge, which teacheth to number well (*viz.*) the Doctrine of Accounting by Numbers. And there are divers Species and Kinds of *Arithmetick* and *Geometry*, the which we do intend to treat of in Order; applying the Principles of the one to the Definitions of the other: For as Magnitude or Greatness is the subject of *Geometry*, so Multitude or Number is the subject of *Arithmetick*; and if so, then their first Principles and chief Fundamentals, must have like Definitions; or at least, a Semblable Congruency.

2. Number, is that by which the Quantity of any Thing is expressed or numbred; as the Unit is the Number by which the Quantity of one Thing is expressed or said to be one, and two by which it is named two, and $\frac{1}{2}$ half by which it is named or called half, and ($\sqrt{3}$) the Root of 3, by which it is called the Root of 3, the like of any other.

3. Hence it is that Unit is Number, for the Part is of the same Matter that is his Whole, the Unit is Part of the Multitude of Units, therefore the Unit is of the same Matter that is of the Multitude of Units; but the Matter of the Multitude of Units is Number, therefore the Matter of Unit is Number; for else if from a given number, no number be subtracted, the number given remaineth; let three be the Number given; from which number subtract or take away one, (which as some conceive is no number) therefore the number given remaineth, that is to say, there remaineth three, which is absurd.

4. Hence it will be convenient to examine from whence Number hath its Riſe or Beginning: Moſt Authors maintain that Unit is the Beginning of Number, and it ſelf no number; but looking upon the Principles and Definitions in the firſt Rudiments of *Geometry*, we ſhall find, that the Definition of a Point is in no way congruous with the Definition of an Unit in *Arithmetick*; and therefore one, or Unit muſt be in the Bounds or Limits of Number, and conſequently the Beginning of Number is not to be found in the number one; wherefore to make number and magnitude congruent in Principles, and like in Definitions, we make and conſtitute a Cypher to be the Beginning of number or rather the medium between encreaſing and decreaſing Numbers, commonly called abſolute or whole Numbers, and negative or fractional Numbers, between which nothing can be imagined more agreeable to the Definition of a Point in *Geometry*, for as a Point is an adjunct of a Line and it ſelf no Line, ſo is (0) Cypher an adjunct of number and it ſelf no number: And as a point in *Geometry* cannot be divided or increaſed into Parts; ſo likewiſe (0) cannot be divided or increaſed into Parts: for as many Points though in number infinite do make no Line, ſo many (0) Cyphers, though in number infinite do make no number. For the line AB cannot be increaſed by the addition of the Point C, neither can the Number D be increaſed by the addition of the (0) Cypher E, for if you add nothing to 6, the Sum will be 6. (0) neither increaſing nor diminiſhing the number 6, but if it be granted that AB be extended or prolonged to the Point C, ſo that AC be made a continued Line, then AB is increaſed by the Addition of the Point C, in like manner if we grant D 6 be prolonged to E (0) ſo that DE (60) be a continued number making 60, the 6 is augmented by the Aid of (0) as to the

A————B
. C.

D 6
E 0
ſum 6

A——B——C

$\left.\begin{matrix} C & E \\ 6 & 0 \end{matrix}\right\} 60$

the constituting the number (60) fixty; and furthermore that one or Unit is material and a Number, and that (o) is the Beginning of number is proved by all Authors altho indirectly, for the Tables of Sines and Tangents prove one Degree to be a Number, because the Sine of 1 Degree is 174524. (the Radius being 1000000) and the Beginning of that Table is (o) and to it answereth oooooo, &c.

5. Hence it is that Number is not Quantity discontinued, for all that which is but one Quantity, is not Quantity disjunct, (60) fixty as it is a Number, is one Quantity, *viz.* one number (60) fixty; therefore as it is number, it is not Quantity disjunct; for number is some such thing in Magnitude, as Humidity in Water; for as Humidity extends it self through all and every part of Water, so number related to magnitude, doth extend it self through all and every part of Magnitude. Also as to continued Water doth answer continued Humidity, so to a continued Magnitude doth answer a continued Number. As the continued Humidity of any intire Water, suffereth the same Division and Distinction that his Water doth; so the continued Number suffereth the same Division and Distinction that his Magnitude doth. From all which Considerations we might enlarge a further Digression concerning number and magnitude, by comparing the Definitions of the one with the Principles of the other, for having found a(o) Cypher to be answerable in Definition to a Point in magnitude, we may very well conclude that number may be congruent to a Line; as also the Figurative Number to be consonant in Definition with a Superficies, and Solid, &c. in the Order of *Geometrical* Magnitudes.

6. The Characters or Notes by which Numbers are signified, or by which a Number is ordinarily expressed are these following, (*viz.*) o Cypher or nothing, 1 One, 2 Two, 3 Three, 4 Four, 5 Five, 6 Six, 7 Seven, 8 Eight, 9 Nine. The Cypher, which though of it self signifieth nothing (*viz.*) expresseth not any certain or known Quantity, but is the Beginning, Radix, or Root of

Number, and the other nine Figures or Characters are called significant Figures or Digits.

7. In Numbers of any sort, two things are to be considered, (*viz.*) Notation and Numeration.

8. Notation teacheth how to describe any Number by certain Notes and Characters, and to declare the Value thereof being so described, and that is by Degrees and Periods.

9. A Degree consists of three Figures. *viz.* of three Places comprehending Units, Tens and Hundreds, so 365 is a Degree, and the first Figure (5) on the Right Hand, stands simply for its own Value, being Units or so many Ones, (*viz.*) five; the second in Order from the Right, signifies as many times Ten, as there are Units contained in it, (*viz*) sixty; the third in the same Order signifies so many Hundreds as it contains Units, so will the Expression of the Number be three hundred sixty five; also 789, is seven hundred eighty nine, &c.

10. A Period is when a Number consists of more than three figures, or Places, and whose proper Order is to prick or distinguish every third Place beginning at the Right Hand, and so on to the Left; so the Number 63452 being given, it will be distinguished thus 63.452, and expressed thus, fixty three thousand four hundred fifty two, likewise 4.578.235.782. being distinguished as you see, will be expressed thus, four thousand five hundred seventy eight millions, two hundred thirty five thousand, seven hundred eighty two.

11. Number is either Absolute or Negative.

12. An Absolute, or Intire, Whole. Increasing Number, is that which by annexing of another Figure or Cypher it becomes ten Times as much as it stood for before; and if two Figures or Cyphers be annexed, it makes it a hundred Times more than it stood for before; &c. as if you annex to the figure 6 a Cypher, then it will become (60) fixty: So if two Cyphers are annexed, then it will be (600) six hundred, and if you do annex to it a (4) four, then it will be (64) sixty four; and if you annex (78) seventy eight, it will be then

then (678) six hundred seventy eight, and so on: By annexing more Figures or Cyphers, it will encrease in a decuple Proportion *ad infinitum*.

13. A Negative, or Broken, Fractional, Decreasing Number, is that which by prefixing a Point or Prick towards the left Hand its Value is decreased from so many Units, to so many tenth Parts of any Thing, and if a Point and (o) Cypher or a Digit be prefixed, it will be then so many hundred Parts, and if a Point and two Cyhers or Digits be prefixed, its Value is decreased to be so many thousand Parts; as if you would prefix before the figure 3 a Point (.) or Prick thus (.3) it is then decreased from 3 Units or Integers to (.3) three, tenth Parts of an Unit or Integer; and if you prefix a Point and Cypher thus (.03) it is decreased from 3 Integers to 3 hundred parts of an Integer, and by this means 5l. Absolute by prefixing of a Point will be decreased .5l. Negative which is five tenth parts of a Pound equal in Value to ten Shillings, and so by prefixing of more Cyphers or Digits, its Value is decreased in a decuple Proportion *ad infinitum*. As in the following Scheme, or rather Order of Numbers, we have placed (o) Cypher in its due Place and Order, as it is both the Beginning and Medium of Number; for going from (o) towards the Left Hand you deal with intire, absolute, whole increasing Numbers.

Increasing Numbers. | *Decreasing Numbers.*

59	876	548	256	2 1 0 1 2	341	678	976	3
mm	mmm	mmm	mmm	CXUXC	mmm	mmm	mmm	m
mm	mmm	mmm	CX		XC	mmm	mmm	m
mm	mmm	CX				XC	mmm	m
mm	CX						XC	
X								

But going from (o) the Place of Units towards the Right Hand you meet with broken, negative fractional and decreasing Numbers. And hence it follows that *Multiplication* encreases the Product in absolute Numbers, but decreaseth the Product in negative Numbers. Also Division decreaseth the Quotient in whole Num-

 bers,

bers, and increaseth it in Negative or Fractional Numbers.

14. An Absolute, Intire, Whole, Increasing *Number* hath always a Point annexed towards the Right Hand; and therefore,

15. A Negative, Broken, Decimal, Decreasing *Number* hath always a Point prefixed before it towards the Left Hand. When we express Integers or whole *Numbears*, as 5 *Pounds*, 5 *Feet*, 26 *Men*, we usually annex a

l feet men. inch

Point or Prick after the number thus, 5. 5. 26. 347. But when we express Decimals, or Numbers that are denyed to be intire, as decreasing *Numbers*, we do commonly prefix a Point or Prick before the said Decimal or decreasing *Number*, thus (.3) that is 3 tenths, or 3 primes, ,03, that is 3 hundredths, or 3 seconds.

16. A Whole or absolute *Number* is an Unit, or a composed Multitude of Units, and it is either a prime, or else a compounded *Number*.

17. Prime *Numbers* amongst themselves are those which have no multitude of Units for a common Measurer as 8 and 7, or 10 and 13, because not any multitude of Units can equally measure or divide them without a Remainder.

18. Compound *Numbers* amongst themselves are those which have a multitude of Units for a common Measurer, as 9 and 12, because 3 measures them exactly, and abbreviates them to 3, and 4.

19. A Broken *Number* commonly called a Fraction, is a Part or Parts of a whole *Number*, *viz.* a Part of an Integer, $\frac{1}{3}$ one third is one third Part of an Unit.

20. A Broken *Number* or Fraction, consists of 2 Parts, *viz.* the Numerator and the Denominator.

21. The Numerator and Denominator of a Fraction, are set one over the other, with a Line between them; and the Numerator is set above the Line, and expresseth the Parts therein contained.

22. The Denominator of a Fraction is the inferiour *Number* placed below the Line, and expresseth the number of Parts into which the Unit or Integer is divided;

as

as let $\frac{3}{4}$ be the Fraction given. so ſhall 3 be the Numerator, and doth expreſs or *number* the multitude of Parts contain'd in this Fraction; for $\frac{3}{4}$ is a Fraction compoſed of Fourths or Quarters; and the figure 3 in *numbering* ſhews us, that in that Fraction there are 3 of thoſe fourth parts or quarters; alſo in the ſame Fraction $\frac{3}{4}$ 4 is the *Denominator* and doth expreſs the Quality of the Fraction, *viz.* that the Whole, or Integer, is here divided into 4 equal Parts.

23. A Broken *Number* is either proper or improper, *viz.* proper, when the *Numerator* is leſs than the *Denominator*; ſo $\frac{3}{4}$ is a perfect proper Fraction, but an improper Fraction hath its *Numerator* greater, or at leaſt equal to the *Denominator*; thus $\frac{14}{4}$ is an improper Fraction, the Reaſon is given in the Definition.

24. A proper broken *Number* is either *Simple* or *Compound*, viz. *Simple*, when it hath one *Denomination*, and *Compound*. when it conſiſteth of divers *Denominations*. If $\frac{3}{4}$l. $\frac{6}{12}$ $\frac{23}{100}$l. were given we ſay they are either of them Single or *Simple Fractions*, becauſe they conſiſt but of one *Numerator* and one *Denominator*; but if $\frac{3}{4}$ of $\frac{6}{12}$ of $\frac{23}{100}$ of a Pound ſterling were given, we ſay, that it is a *compound broken Number, or Fraction.* becauſe the Expreſſion & Repreſentation conſiſteth of more *Denominations* than one; and ſuch by ſome are called *Fractions of Fractions*, and they have always this Particle (of) between them.

25. When a ſingle *broken Number* or *Fraction*, hath for his *Denominator* a *Number* conſiſting of an Unit in the firſt Place towards the left Hand, and nothing but Cyphers from the Unit towards the right Hand, it is then the more aptly and rightly called a *Decimal Fraction*; under this Head are all our decreaſing *Numbers* placed, and in our 13*th Definition* called Negative, and by that Order there preſcribed, we order them to be *Decimals*, by ſigning a Point or Prick before them, or the *Numerator* rejecting the *Denominator*: Therefore according to our laſt Rule, $\frac{5}{10}$ $\frac{5}{100}$ $\frac{25}{100}$ $\frac{23}{1000}$, are ſaid to be *Decimals*; and a *Decimal Fraction* may be expreſſed without its *Denominator* (as before) by prefixing a Point or Prick before the *Numerator* of the ſaid *Fraction*, and then ſhall the former

Fraction

Fractions $\frac{5}{10}$, and $\frac{25}{100}$, stand thus .5 and .25.

But oftentimes as in the Second and Fourth *Fractions* $\frac{5}{100}$ and $\frac{25}{1000}$ a Prick or Point will not do without the Help of a Cypher or Cyphers prefixed before the significant figures of the *Numerator*, and therefore when the *Numerator* of a *Decimal Fraction*, consisteth not of so many places as the *Denominator* hath Cyphers, fill up the void places of the *Numerator*, with prefixing Cyphers before the Significant Figures of the *Numerator*, and then sign it for a *Decimal* so shall $\frac{5}{100}$ be .05 and $\frac{25}{1000}$ will be .025, and $\frac{72}{100000}$ will be .00072. Now by this we may easily discover the *Denominator* having the *Numerator*; for always the *Denominator* of any *Decimal Fraction* consists of so many Cyphers, as the *Numerator* hath Places, with an Unit prefixed before the said Cyphers, *viz.* under the Point or Prick.

26. A *Decimal Number* or *Fraction*, is that which is expressed by *Primes*, *Seconds*, *Thirds*, *Fourths*, &c, and is Number decreasing. Here instead of *Natural* and *Common Fractions*, as $\frac{1}{4}$ of a Thing, we order the Thing or Integer into *Primes*, *Seconds*, *Thirds*, *Fourths*, *Fifths*, &c. that our Expression may be consonant to our former Order.

27. In *Decimal Arithmetick* we always imagine (and it would be very commodious if it were really so) that all intire Units, Integers, and Things are divided first into ten equal Parts, and these Parts so divided we call *Primes*; and *Secondly*, we divide also each of the former *Primes* into ten equal Parts & every of these Divisions we call *Seconds*; and thirdly, we divide each of the said *Seconds* into ten other equal Parts, and those so divided we call *Thirds*, and so by decimating the former, and subdecimating these latter we run on *ad infinitum*.

28. Let a pound sterling, *Troy-weight*, *Averdupois-weight*, *Liquid-measure*, *Dry-measure*, *Long-measure*, *Time*, *Dozen*, or any other Thing, or Integer be given to be *Decimally* divided; in this Notion premised we ought to let the first Division be *Primes*, the next Division *Seconds*, the next *Thirds*, &c. So one pound Sterling being 20 Shillings, which divided into ten equal Parts, the Value of each Part will be two Shillings; therefore one *Prime* of a

pound

pound Sterling will ſtand thus (.1), which is in Value 2 Shillings, three *Primes* will ſtand thus (.3), and that is in Value 6 Shillings. Again a *Prime* or .1 being divided into ten equal Parts, each of thoſe Parts will be one *Second*, and is thus exptreſſed, (.01), and its Value will be found to be 2d. Farthing, and $\frac{6}{10}$ of a Farthing; and ſo will .05 ſignify one Shilling, or five *Seconds*. And if .01 be divided into ten other equal Parts. each of thoſe Parts ſo divided will be *Thirds* and will ſtand thus .001, and its Value will be found to be .96 of a Farthing, or $\frac{96}{100}$ of a Farthing; and .009 *Thirds* will be 2d. and .64 of a Farthing. $\frac{64}{100}$ of a Farthing, *&c.* So that .375l. will be found to repreſent 7 s. and 6d. for the 3 *Primes* are 6 Shillings, and the 7 *Seconds* are 1 s. 4d. and $\frac{8}{10}$ of a Peany, and the five *Thirds* are 1 Penny and $\frac{2}{10}$ of a Penny, both which added together make 7 s. 6d.

29. If you put any Bulk or Body repreſenting an Integer. & it be *decimally divided*, then the Parts in the firſt Decimation are *Primes*, the next *Seconds*, and the next Decimation is *Thirds* the next *Fourths*, &c. As let there be given a Bullet of Lead, or ſuch like whoſe Weight let it be 50l. *Troy*, this call an Unit, Integer, or Thing, then with the like Weight and Matter, make 10 other, the which together will be equal to 50l. and will weigh each of them 5l. a Piece, take of the ſame Matter, and equal to 5l. make 10 more, then each of thoſe will weigh 6 Ounces a Piece; alſo if again, you take 6 Ounces, and thereof make 10 other ſmall Bullets, each of them will weigh 12 penny-weight *Troy*; and thus have you made *Primes*, *Seconds*, and *Thirds*, in reſpect of the Integer containing 50l. *Troy*; and that 5 *Primes* is equal to the half Maſs, and 2 *Primes* and 5 *Seconds*. is a Quarter of the Maſs, and therefore 1 of the firſt Diviſion, 2 of the ſecond Diviſion, and 5 of the third Diviſion. will be equal in Weight to half a quarter of the Maſs, and contain 6 l. and 3 Ounces.

30. When a *Decimal Fraction* followeth a whole *Number*, you are to ſeparate or part the *Decimal* from the whole *Number*, by a Point or Prick; ſo if .75 follow the whole

Num-

Number 32, ſet them thus 32.75. You ſhall find that divers Authors have divers ways in expreſſing mixt *Numbers* as thus, 32|75, or 32 $\frac{75}{100}$, or 32.$\dot{7}\dot{5}$ or 32|$\underline{75}$, or 32;75, but you will find that 32.75, thus placed and expreſſed is fitteſt for Calculation.

31. A mixt *Number* hath 2 Parts, the whole and the broken; the whole is that which is compoſed of Integers, and the broken is a *Fraction* annexed thereunto. So the mixt *Number* 36 $\frac{8}{12}$ being given, we ſay that 36 is the whole *Number*, which is compoſed of Integers, and the $\frac{8}{12}$ is the broken *Number* annexed, which ſheweth that one of the former Integers (of that 36) being divided into 12 Parts, this $\frac{8}{12}$ doth expreſs 8 of thoſe 12 Parts more belongſng to the ſaid 36 Integers.

32. *Denominative Numbers* are of one, or of many and thoſe are of divers ſorts and kinds, *viz.* *Singular*, called Unit, as 1; and *Plural*, called Multitude; as 2, 3, 4, 5, *Single* of one kind only, called *Digits*, as 1, 2, 3, 4, 5, 6, 7, 8, 9, and *Compounds* of many, 10, 11, 12, *&c.* 102, 367, *&c.*

Proportional, as Single, Multiple, Double, Triple, Quadruple, *&c.* Denominate, as Pounds, Shillings, Pence; Undenominate, as 1, 2, 3, *&c.* Perfect, as 6, 28, 496, 8128, 130816, 2099128, *&c.* whoſe Parts are equal to the numbers; Imperfect, unequal and more than the Sum, as 12 to 1, 2, 3, 4, 6. Imperfect unequal and leſs than the Sum, as 8 to 1, 2, 4. Numbers Commenſurable and Incommenſurable, as 12 and 9 are Commenſurable becauſe 3 meaſures both. But 6 and 17 are Incommenſurable, becauſe no one common *Number* or *Meaſure* can meaſure them.

Linear in form of a Line, as .... Superficial in Form of a Superficies or Plane, as :::: or ⁝⁝, *&c.* and Number cubical or ſolid in Form of a Cube. Theſe two latter are otherwiſe called figurative Numbers: There are alſo other Numbers called Tabular, as Sines, Tangents, Secants, *&c.* Others that be called Logarithms or borrowed Numbers, fitted to proportion for Eaſe and ſpeedy Calculation of all Manner of Queſtions.

CHAP.

CHAP. II.

Of the Natural Division of Integers, and the several Denominations of the Parts.

1. BEfore we come to Calculation or the Ordering of *Numbers* to operate any Arithmetical Question proposed, we will lay down Tables of the Denomination of several Integers; and after that (having mentioned the several Species or Kinds of Arithmetick) we shall immediately handle the Species of Numeration which are the main Pillars upon which the whole Fabric of this Art is built.

Of Money, Weights, &c.

2. The least Denomination or Fraction of Money used in *England* is a Farthing, from whence is produced the following Table, called the *Table of Coin, viz.*

1 *Farth.*	make	1 *Farthing*
4 *Farth.*	make	1 *Penny*
12 *Pence*	make	1 *Shilling*
20 *Shill.*	make	1 *Pound*

And therefore

l.	s.	d.	qrs.
1	20	12	4
1	20	240	960
	1	12	48
		1	4

The first of these Tables, *viz.* that on the Left-Hand, is plain and easie to be understood, and therefore wants no Directions. In the second Table above the Line you have 1 *l.* 20 *s.* 12 *d.* 4 *qrs.* whereby is meant that 1 Pound is equal to 20 Shillings, and one Shilling is equal to 12 Pence, and one Penny is equal to 4 Farthings, under the Line is 1 *l.* 20 *s.* 240 *d.* 960 *qrs.* which signifies one Pound to contain 20 Shillings, or 240 Pence, or 960 Farthings; in the second Line below that 1 *s.* 12 *d.* 48 *qrs.* the

the first standing under the Denomination of Shillings, whereby is to be noted that one Shilling is equal to 12 Pence, or 48 Farthings, and likewise that below that, one Penny is equal in Value to four Farthings; understand the like Reason in all the following Tables of Weight, Measure, Time, Motion and Dozens.

Of Troy-weight.

3. The least Fraction or Denomination of Weight used in *England*, is a Grain of Wheat gathered out of the Middle of the Ear, and well dryed; from whence are produced these following Tables of Weight called *Troy-weight*.

32 *Grains of Wheat*	make	24 *Artificial Grains*
24 *Artificial Grains*	make	1 *Penny-weight*
20 *Penny-weight*	make	1 *Ounce*
12 *Ounces*	make	1 *Pound Troy-weight*

And therefore,

l.	*oun.*	*p. w.*	*grains;*
1	12	20	24
1	12	240	5760
	1	20	480
		1	24

Troy-weight serveth only to weigh Bread, Gold, Silver, and Electuaries; it also regulateth & prescribeth a Form how to keep the Money of *England* at a certain standard. The *Goldsmiths* have divided the Ounce *Troy-weight* into other Parts, which they generally call Mark-weight; the Denominative Parts thereof are as followeth, viz. A Mark (being an ounce Troy) is divided into 24 equal Parts, called Carects and each Carect into 4 grains so that in a Mark are 96 Grains; by this Weight they distinguish the different Fineness of their Gold; for if

so

to the Fineness of Gold be put 2 Carects of Alloy (which is of Silver, Copper, or other baser Metal, with which they use to mix their Gold or Silver to abate the Fineness thereof) both making when cold but an Ounce or 24 Carects, then this Gold is said to be 22 Carects fine, for if it come to be refined the 2 Carects of Alloy will fly away, and leave only 22 Carects of pure Gold, the like to be considered of a greater or lesser Quantity; and as the Fineness of Gold is estimated by Carects, so the Fineness of Silver is distinguished by Ounces; for if a Pound of it be pure, & loseth nothing in the Refining, such Silver is said to be Twelve Ounces fine; but if it loseth any Thing it is said to contain so much Fineness as the Loss wanteth of 12 Ounces, as if it lose an Ounce, it is said to be 11 Ounces fine, and if it lose 1 Ounce 14 Penny-weight, then it is said to be 10 Ounces 6 Penny-weight fine, and that which loseth 2 Ounces 4 Penny-weight 16 Grains, is said to be 9 Ounces 15 Penny-weight 8 Grains fine, *&c.* the like of a greater or lesser Quantity.

Of Apothecaries Weights.

4. The *Apothecaries* have their Weights deduced from *Troy-weight*, a Pound *Troy*, being the greatest Integer, a Table of whose Division and Sub-division, followeth, *viz.*

12 *ounces*	make	1 *pound*
8 *drams*	make	1 *ounce*
3 *scruples*	make	1 *dram*
20 *grains*	make	1 *scrup.*

And therefore.

l.	*oun.*	*dram.*	*scrup.*	*gr.*
1	12	8	3	20
1	12	96	288	5760
	1	8	24	480
		1	3	60
			1	20

5. Thus much concerning *Troy Weight*, and its derivative Weights, (which as was said before) serveth to weigh Bread, Gold, Silver, and Electuaries; now besides *Troy-weight* there is another kind of Weight used in *England* commonly known by the Name of *Avoirdupois-weight* (a pound of which is equal to 14 Ounces 12 Penny-weight *Troy-weight*) and it serveth to weigh all kinds

 of

of Grocery-wares, as also *Butter, Cheese, Flesh, Wax, Tallow, Rozen, Pitch, Lead,* and all such kind of Garble, the Table of which Weight is as followeth.

The Table of Averdupois Weight.

4 *quarters of a dram*	make	1 *dram*
16 *drams*		1 *ounce*
16 *ounces*		1 *pound*
28 *pounds*		1 *quarter of an Hundred*
4 *quarters*		1 *Hundred wei. or 112l.*
20 *hundred*		1 *Tun*

And therefore,

Tun	*C.*	*qrs.*	*l.*	*oun.*	*dra.*	*qrs.*
1	20	4	28	16	16	4
1	20	80	2240	35840	573440	2293760
	1	4	112	1792	28672	114688
		1	28	448	7168	28672
			1	16	256	1024
				1	16	64
					1	4

Wool is weighed with this Weight, but only the Divisions are not the same; a Table whereof followeth.

A Table of the Denominative Parts of Wool-Weight.

7 *pound*	make	1 *clove*
2 *cloves*		1 *stone*
2 *stones*		1 *todd*
6 *todd 1 stone*		1 *wey*
2 *weys*		1 *sack*
12 *sacks*		1 *last*

And therefore,

Last	*Sacks*	*Wey*	*Todd*	*Stone*	*Cloves*	
1	12	2	$6\frac{1}{2}$	2	2	7
1	12	24	156	312	624	4368
	1	2	13	26	52	64
		1	$6\frac{1}{2}$	13	26	182
			1	2	4	28
				1	2	14
					1	7

Note,

Note, That in some Counties, the *Wey* is 256*l.* *Aver-dupois*, as is the *Suffolk* Wey; but in *Essex* there is 336*l.* in a Wey.

The least Denominative Part of *Liquid-Measure* is a Pint which was formerly taken from *Troy weight* (a Pound of Wheat *Troy-weight* making 1 Pint of Liquid-Measure) but in regard of the Difference between the Brewers and the Farmers of His Majesty's Excise concerning the Gaging of Vessels occasion'd by the different Opinions of Artists, concerning the Solid Inches in a Gallon; it was lately decided by Act of Parliament, the Statute making 282 Solid Inches in a Beer Gallon, and 231 in Wine-Measure, and consequently the Pint Beer-Measure to contain $35\frac{1}{4}$ Solid Inches, and the Pint Wine Measure to contain $28\frac{7}{8}$ Cubical or Solid Inches, from whence is drawn the following Table.

The Table of Liquid Measure.

$35\frac{1}{4}$ *cubical Inches*	make	1 *pint beer-measure*
$28\frac{7}{8}$ *cubical Inches*		1 *pint wine-measure*
2 *pints*		1 *quart*
2 *quarts*		1 *pottle*
2 *pottles*		1 *gallon*
8 *gallons*		1 *firk. of ale, soap, or herrings*
9 *gallons*		1 *firk. of beer*
10 *gallons and a half*		1 *firk of Salmon or Eels*
2 *firkins*		1 *kilderkin*
2 *kilderkins*		1 *barrel*
42 *gallons*		1 *tierce of wine*
63 *gallons*		1 *hogshead*
2 *hogsheads*		1 *pipe or butt*
2 *pipes or butts*		1 *tun of wine*

And therefore,

Tun	*pipes*	*hgds.*	*gal.*	*pts.*
1	2	2	63	8
1	2	4	252	2016
	1	2	126	1008
		1	63	504
			1	8

7. The least Denominative Part of *Dry-measure* is also a Pint, and this is likewise taken from *Troy-weight*. The Table of whose Division followeth.

The Table of Dry-Measure.

1 *pound Troy*	make	1 *pint*
2 *pints*		1 *quart*
2 *quarts*		1 *pottle*
2 *pottles*		1 *gallon*
2 *gallons*		1 *peck*
4 *pecks*		1 *bushel*
4 *bushels*		1 *comb*
2 *combs*		1 *quarter*
4 *quarters*		1 *chaldron*
5 *quarters*		1 *wey*
2 *weys*		1 *last*

And therefore,

last	*wey*	*qrs.*	*com.*	*bush.*	*pecks*	*gall.*	*pints*
1	2	5	2	4	4	2	8
1	2	10	20	80	320	640	5120
	1	2	10	40	160	320	2560
		1	5	8	32	64	512
			1	4	16	32	256
				1	4	8	64
					1	2	16
						1	8

8. The least Denominative Part of *Long-Measure* is a Barly-Corn well dryed, and taken out of the Middle of the Ear; whose Table of Parts followeth.

The Table of Long-Measure.

3 *barly-corns*	make	1 *inch*
12 *inches*		1 *foot*
3 *feet*		1 *yard*
3 *feet 9 inches, or a yard and quarter*		1 *ell English*
6 *feet*		1 *fathom*
5 *yards and a half*		1 *pole, perch or rood*
40 *poles or perches*		1 *furlong*
8 *furlongs*		1 *English mile*
7 *yards*	make	1 *Irish perch.*

And

And therefore,

mile	furl.	poles	yards	feet	inches	barly-corns
1	8	40	5½	3	12	3
1	8	320	1760	5280	63 60	100080
	1	40	220	660	7920	23760
		1	5½	16½	198	584
			1		36	108
				1	12	36
					1	3

And *Note* that the Yard, as also the Ell, is usually divided into 4 Quarters, and each Quarter into 4 Nails.

Note, also that a Geometrical Pace is 5 Feet; and there are 1056 such Paces in an *English* Mile.

2. The Parts of the Superficial Measures of Land are such as are mentioned in the following Table, *viz.*

The Table of Land-Measure.

40 *Square Poles or Perches*	make	1 *Rood, or quarter of an Acre*
4 *Roods*		1 *Acre* side of an Acre 12 ⅔ perches

see Hill

By the foregoing *Table of Long Measure*, you are informed what a Pole, or (which is all one) Perch is; a Square Perch is a Superficies very aptly resembled by a Square Trencher, every side thereof being a Perch or 5 Yards and a half in Length, 40 of them is a Rood, and 4 Roods an Acre. So that a Superficies that is 40 Perches Long and 4 Broad is an Acre of Land, the Acre containing in all 160 Square Perches.

10. The least Denominative Part of Wine [illegible]; the greatest Integer being a Tun; from whence is produced this follo[illegible]

The Table of Time.

1	*Minute*	make	1 *Minute*
60	*Minutes*		1 *Hour*
24	*Hours*		1 *Day natural*
7	*Days*		1 *Week*
4	*Weeks*		1 *Month*
13	*Months,* 1 *Day,* 6 *Hours,*		1 *Year*

But the Year is usually divided into 12 unequal *Kalendar Months*, whose Names and the Number of Days that they contain, follow, *viz.*

	Days
January	31
February	28
March	31
April	30
May	31
June	30
July	31
August	31
September	30
October	31
November	30
December	31

So that the Year containeth 365 Days, and 6 Hours, but the 6 Hours are not reckon'd but only every 4th Year, and then there is a Day added to the latter End of *February*, and then it containeth 29 Days; and that Year is called *Leap-Year*, and containeth 366 Days.

And here Note, that as the Hour is divided into 60 Minutes, so each Minute is subdivided into 60 Seconds, and each Second into 60 Thirds, and each Third into 60 Fourths, *&c.*

The Tropical Year by the exactest Observations of the most Accurate Astronomers is found to be 365 Days, 5 Hours, 49 Minutes, 4 Seconds, and 21 Thirds.

CHAP. [illegible]

Of the Species [illegible] *Arithmetick.*

1. ARithmetick is [illegible]l, Artificial, Analytical, [illegible]l, or Instrumental.

2. Natural

2. Natural Arithmetick is that which is perform'd by the Numbers themselves; and this is either Positive or Negative. Positive which is wrought by certain infallible Numbers propounded, and this either Single or Comparative; Single which considereth the Nature of *Numbers* simply by themselves, and Comparative, which is wrought by *Numbers* as they have Relation to one another. And the Negative Part relates to the Rule of *False*.

3. Artificial (by some called Logarithmetical) Arithmetick, is that which is perform'd by Artificial or Borrowed *Numbers* invented for that Purpose, and are called Logarithms.

4. Analytical Arithmetick, is that which shews from a Thing unknown to find truly that which is sought; always keeping the Species without Change.

5. Algebraical Arithmetick, is an Obscure and Hidden Art of Accompting by Numbers in Resolving of hard Questions.

6. Lineal Arithmetick, is that which is perform'd by Lines fitted to Proportions, as Geometrical Projections.

7. Instrumental Arithmetick, is that which is perform'd by Instruments fitted with Circular and Right Lines of Proportion, by the Motion of an Index or otherwise.

8. The Parts of Single Arithmetick are Numeration and the Extraction of Roots.

9. Numeration is that by which certain known Numbers propounded, we discover another Number Unknown.

10. Numeration hath four Species; *viz.* Addition, Subtraction, Multiplication, and Division.

CHAP. IV.

Of [illegible] of Whole Numbers.

ADdition is the [illegible] of two or more Numbers of like kind [illegible] one Sum or Total.

[illegible]

Or it is that by which divers *Numbers* are added together, to the end that the Sum or Total Value of them all may be discovered.

The First *Number* in every *Addition* is called the Addible *Number*, the other the *Number* or *Numbers* added, and the *Number* invented by the *Addition* is called the *Aggregate* or *Sum* containing the Value of the *Addition*.

The Collation of the Numbers, is the right Placing of the Numbers given respectively to each Denomination, and the Operation is the Artificial Adding of the Numbers given together, in order to the finding out of the *Aggregate* or *Sum*.

2. In *Addition*, Place the Numbers given respectively the one above the other, in such sort, that the like Degree, Place, or Denomination, may stand in the same Series, *viz.* Units under Units, Tens under Tens, Hundreds under Hundreds, *&c.* Pounds under Pounds, Shillings under Shillings, Pence under Pence, *&c.* Yards under Yards, Feet under Feet, *&c.*

3. Having thus placed the Numbers given (as before) and drawn a Line under them. Add them together, beginning with the lesser Denomination, *viz.* at the Right Hand, and so on, Subscribing the Sum under the Line respectively; as for Example.

Let there be given 3352 and 213 and 133 to be added together, I set the Units in each particular Number under each other, and so likewise the Tens under the Tens, *&c.* and draw a Line under them, as in the Margin, then I begin at the Place of Units, and add them together upwards, saying, 3 and 3 are 6 and 2 make 8, which I set under the Line, and under the same Figures added together; then I proceed to the next Place being the Place of Tens, and add them up in the same Manner, as I did the Place of Units, saying, 3 and 1 are 4 and 5 are 9, which I likewise set under the Line respectively; then I go on to the Place of Hundreds, and add them up as I did the other, saying, 1 and 2 are 3 and 3 are 6, which I also set under the Line, and lastly, I go to the Place of Thousands, and

$$\begin{array}{r} 3352 \\ 213 \\ 133 \\ \hline 3698 \end{array}$$

and becauſe there are no other Figures to add to the 3, I ſet it under the Line in its reſpective Place, and ſo the Work is finiſhed; and I find the Sum of the 3 given Numbers to be 3698.

4. But if the Sum of the Figures of any Series exceeds Ten, or any Number of Tens, ſubſcribe under the ſame the Exceſs above the Tens, and for every Ten carry One to be added to the next Series towards the Left Hand, and ſo go on until you have finiſhed your Addition; always remembring, that how great ſoever the Sum of the Figures of the laſt Series is, it muſt all be ſet down under the Line reſpectively. So 3678 being given to be added to 2357. I ſet them down as is before directed, and as you ſee in the Margin, with a Line drawn under them, then I begin and add them together. ſaying 7 and 8 are 15, which is 5 above 10, wherefore I ſet 5 under the Line, and carry 1 for the 10 to be added to the next Series, ſaying, 1 that I carried and 5 is 6 and 7 are 13, wherefore I ſet down 3 and carry 1 (for the Ten) to the next Series, then I ſay 1 that I carry'd and 3 are 4 and 6 are 10, now becauſe it comes to juſt 10 and no more, I ſet 0 under the Line and carry 1 for the 10 to the next, and ſay, 1 that I carry'd and 2 are 3 and 3 are 6, which I ſet down in its reſpective Place, thus the Addition is ended, and the Total Sum of theſe Numbers is found to be 6035; ſeveral Examples of this kind follow.

3678
2357
6035

Numbers to be added	354867
	573846
	785946
	347205
Sum	2061864

Numbers to be added { 748647, 465834, 76483, 648300 }

Sum 1939264

Numbers to be added { 45346, 38074, 8437, 923, 76 }

Sum 29856.

5. If the Numbers given to be added, are contained under divers Denominations; as of Pounds, Shillings, Pence, and Farthings; or of Tuns, Hundreds, Quarters, Pounds, &c. Then in this Case having disposed of the Numbers, each Denomination under other of like kind; beginning at the least Denomination, (minding how many of one Denomination do make an Integer of the next) and having added them up, for every Integer of the next greater Denomination that you find therein contained, bear an Unit in mind to be added to the said next greater Denomination, expressing the Excess respectively under the Line, proceed in this Manner until your Addition be finished the following Examples will shew the Rule plain to the Learner. Thus these several Sums being given to be added, viz. 136l. 13s. 4d. 2 qrs. and 79l. 07s. 10d. 3qrs. and 33l. 18s. 09d. 1 qr. also 15l. 09s. 05d. 0qrs. The Numbers being disposed according to Order, will stand as in the Margin Then I begin at the Denomination of Farthings, and add them up, saying 1 and 3 are 4 and 2 make 6, now I consider that 6 Farthings is 1 Penny and 2 Farthings, wherefore I set down the 2 Farthings in its Place under the Line, and keep 1 in Mind to be added to the next Denomination of Pence; then I go on, saying 1 that I carry'd and 5 are 6 and 9 are 15 and 10 are 25 and 4 are 29, now I consider that 29 Pence are 2 Shillings and 5 Pence, whereof I set the 5 Pence in Order under the Line and keep 2 in Mind for the 2 Shillings to be added

l	s.	d.	qrs.
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	0

added to the Shillings; then I go on, saying, that 2 I carry'd and 9 are 11, and 18 are 29, and 7 are 36 and 13 are 49; then I consider that 49 Shillings are 2 Pounds and 9 Shillings, wherefore I set the 9 Shillings under the Line, and carry 2 for the 2 Pounds, to the next and last Denomination of Pounds, and proceed, saying 2 that I carry'd and 5 make 7, and 3 are 10, and 9 are 19, and 6 are 25; then I set down 5 and carry 2 for the Tens, and proceed, saying, 2 that I carry and 1 is 3, and 3 are 6; and 7 are 13, and 3 make 16; I set down 6 and carry 1 for the 10, and go on saying 1 that I carry'd and 1 are 2, which I set in its Place under the Line, and the Work is finished; and thus I find the Sum of the aforesaid Numbers to be 265l. 9s. 5d. 2qrs. This to the Ingenious Practitioner is sufficient, but I shall (for the further illuminating of Weaker Apprehensions) explain the Operation of another Example in *Troy-Weight*; and here the Learner must take Notice of the Table of *Troy-Weight*, mentioned or set down in the Third Section of the Second Chap. The Numbers given in this Example are 38l. 7oz. 13 p. w. 18 gr. and 50l. 10 oz. 10 p. w. 12 gr. and 42l. 08. oz. 05 p. w. 16 gr. and in order to the Addition thereof I place them as you see, and proceed to Operation; saying, 16 and 12 are 28, and 18 are 46; now because 24 Grains are 1 Penny-Weight, 46 Grains are 1 Penny-Weight and 22 Grains; wherefore I set down 22 and carry 1 for the Penny-Weight, and going on I say 1 that I carry and 5 make 6, and 10 are 16, and 13 are 29, which is 1 Ounce and 9 Penny-Weight, I set down 9 in its Place under the Line, and carry 1 to the Ounces, saying, 1 that I carry and 8 are 9 and 10 are 19 and 7 are 26, and because 26 Ounces make 2 Pound 2 Ounces, I set down 2 for the Ounces, and carry 2 to the Pounds; going on, 2 that I carry and 2 are 4, and 8 make 12, that is 2 and go 1; then 1 I carry and 4 are 5, and 5 are 10, and 3 are 13, which I set

l.	oz.	p. w.	gr.
38	07	13	18
50	10	10	12
42	08	05	16
132	02	09	22

ſet down as in the Margin, and the Work is finiſhed, and I find the Sum of the ſaid Number to amount to 132l. 2 oz. 9 p.w. 22 gr. This is ſufficient for the Underſtanding of the following Examples or any other that ſhall come to thy View. The Way of Proving theſe, or any Sums in this Rule, ſhewed immediately after the enſuing Examples.

Addition of Engliſh Money.

l.	s.	d.	qrs.
436	12	07	1
184	00	10	3
768	17	04	2
564	11	11	0
1954	02	09	2

l.	s.	d.	qrs.
48	15	11	1
76	10	07	3
18	00	05	3
24	19	09	2
168	06	10	1

Addition of Troy Weight.

l.	oz.	p.w.	gr.
15	07	13	12
18	06	04	20
11	10	16	18
09	04	10	22
19	11	11	04
22	00	00	00
97	04	17	04

l.	oz.	p.w.	gr.
143	09	12	18
736	08	14	10
383	07	06	12
83	00	16	20
130	03	10	12
74	05	15	00
1551	08	16	00

Addition of Apothecaries-Weights.

l.	oz.	dr.	ſc.	gr.
48	07	1	0	14
74	05	5	2	10
64	10	7	1	16
17	08	1	0	11
34	09	6	1	09
240	05	6	1	00

l.	oz.	dr.	ſc.	gr.
60	03	4	0	10
48	10	6	0	14
34	08	2	1	15
18	11	2	2	11
160	07	1	2	15
35	02	5	1	07
358	07	7	0	12

Addition

Addition of Averdupois Weight.

Tun	C.	qrs.	l.
75	13	1	15
48	07	3	21
60	11	1	17
21	07	0	25
12	16	0	11
218	16	0	5

l.	oun.	dr.
36	10	12
22	11	13
11	07	04
15	04	10
20	00	09
106	03	00

Addition of Liquid Measure.

Tun	pipe	hhd.	gall.
45	1	1	48
15	0	1	17
38	0	0	47
12	1	0	56
21	1	1	18
133	1	1	60

Tuns	hhds.	gall.	pts
30	3	40	4
12	2	28	6
47	3	60	5
57	3	22	3
17	0	00	0
166	1	26	2

Addition of Dry Measure.

Chald.	qrs.	bush.	pec.
48	3	7	3
13	1	4	0
54	0	6	2
16	3	6	1
40	2	0	1
173	3	0	3

qrs.	bush.	pec.	gall.
17	3	1	1
50	1	3	0
14	5	3	1
40	2	0	1
30	0	3	0
152	5	3	1

Addition of Long Measure.

yards	qrs.	nails
35	1	3
14	3	2
74	2	3
38	0	1
30	1	0
15	0	0
208	1	1

ells	qrs.	nails
56	3	3
13	1	2
48	2	1
50	1	0
74	0	2
17	1	0
260	0	0

Addition of Land Measure.

Acre	rood	perch
12	3	18
14	0	24
30	2	19
48	3	30
28	1	38
50	3	26
185	3	35

Acre	rood	perch
86	1	36
47	3	24
73	2	18
60	0	07
04	2	08
14	1	14
286	3	27

The Proof of Addition.

6. *Addition* is proved after this manner, when you have found out the Sum of the Numbers given, then separate the uppermost line from the rest with a stroke or dash of the Pen, and then add them all up again as you did before, leaving out the uppermost line, and having so done add this New invented Sum to the uppermost line you separated, and if the Sum of those 2 lines be equal to the Sum first found out, then the Work was performed true, otherwise not. As for Example, Let us prove the first Example of Addition of Money

Money, whose Sum we found to be 265l 9s. 5d. 2qrs. and which we prove thus. having separated the uppermost Number from the rest, by a line as you see in the Margin, then I add the same together again leaving out the said uppermost line, and the Sum thereof I set under the first or true sum which doth amount to 128l. 16s. 1d. 0qrs. then again I add this new sum to the uppermost line that before was separated from the rest, and the sum of these two is 265l. 09s. 05d. 2qrs. the same with the first Sum and therefore I conclude that the Operation was rightly performed.

l.	s.	d.	qrs.
136	13	04	2
79	07	10	3
33	18	09	1
15	09	05	0
265	09	05	2
128	16	01	0
265	09	05	2

7. The main End of *Addition* in Questions resolvable thereby, is to know the sum of several Debts, Parcels, Integers, *&c.* Some Questions may be these that follow.

Quest. 1. There was an old Man whose Age was required, to which he replyed, I have seven Sons, each having two years between the Birth of each other, and in the 44th year of my Age my eldest Son was born, which is now the Age of my youngest; I demand what was the old Man's Age?

Now to resolve this Question, first set down the Father's Age at the Birth of his first Child, which was 44, then the Difference between the eldest and the youngest which is 12 years and then the Age of the youngest which is 44, and then add them all together, and their Sum is 100, the compleat Age of the Father.

44
12
44
100

Quest. 2. A Man lent his Friend, at several times, these several Sums *viz.* at one time 63l. at another time 50l. at another time 48l. at another time 156l. Now I desire to know how much was lent him in all.

See

Set the Sums lent one under another, as you see in the Margin, and then add them together, and you will find their Sum to amount to 317l. which is the Total of all the several Sums lent, and so much is due to the Creditor.

l.
63
50
48
156
317

Quest: 3: From *London* to *Ware*, is 20 Miles, thence to *Huntington*, 19 Miles, thence to *Stamford*. 21 Miles, thence to *Tuxford*, 36 Miles, thence to *Wentbridge* 25 Miles, from thence to *York* 20 Miles. Now I desire to know how many Miles it is from *London* to *York*, according to this Reckoning.

Now to answer to this Question, set down the several Distances given, as you see in the Margin, and add them together, and you will find their Sum to amount to 151, which is the true Distance in Miles, between *London* and *York*.

20
19
21
36
25
20
151

Quest. 4. There are two Numbers, the least whereof is 40, and their Difference is 14, I desire to know what is the greater Number, and also what is the Sum of them both? First set down the least, *viz*. 40. and 14 the Difference, and add them together, and their Sum is 54 for the greatest Number, then I set 40 (the least) under 54 (the greatest) and add them together, and their Sum is 94, equal to the Sum of the greatest and least Numbers.

	40
	14
greatest	54
least	40
sum	94

CHAP. V.

Of Subtraction of Whole Numbers.

SUbtraction is the taking of a lesser Number out of a greater of like kind, whereby to find out a third Num-

Number, being or declaring the Inequality, Excess or Difference between the Numbers given; or *Subtraction* is that by which one Number is taken out of another Number given, to the end that the Residue or Remainder may be known which Remainder is also called the *Rest*, *Remainder*, or *Difference* of the Numbers given.

2. The Number out of which Subtraction is to be made, must be greater or at least equal with the other Number given; the higher or superior Number is called the major Number, and the lower or inferior is called the minor Number, and the Operation of *Subtraction* being finished, the Rest or Remainder is called the Difference of the Numbers given.

3. In *Subtraction* place the Numbers given respectively, the one under the other, in such sort as like Degrees, Places, or Denominations, may stand in the same Series, *viz.* Units under Units, Tens under Tens, *&c.* Pounds under Pounds, *&c.* Feet under Feet, and Parts under Parts, *&c.* This being done, draw a Line underneath as in *Addition*.

4. Having placed the Numbers given, as is before directed, and drawn the Line under them, subtract the lower Number (which in this case must always be lesser than the uppermost) out of the higher Number, and subscribe the Difference or Remainder respectively below the Line; and when the Work is finished, the Number below the Line will give you the Remainder: As for Example, let 364521 be given to be subtracted from 795836, I set the lesser under the greater, then beginning at the right Hand, I say, 1 out of 6 and there remains 5, which I set in order under the Line; then I proceed to the next, saying 2 from 3 rests 1, which I note also under the Line and thus I go on until I have finished the Work, and then I find the Remainder or Difference to be 431315.

$$\begin{array}{r} 795836 \\ 364521 \\ \hline 431315 \end{array}$$

5. But if it so happen (as commonly it doth) that the lowermost Number or Figure is greater than the uppermost; then in this case add Ten to the uppermost Num-

Number, and ſubtract the ſaid lowermoſt Number from their Sum, and the Remainder place under the Line, and when you go to the next Figure below, pay an Unit by adding it thereto for the Ten you borrowed before, and ſubtract that from the higher Number or Figure: And thus go on until your Subtraction be finiſhed. As for Example, Let 437503 be given, from whence it is required, to ſubtract 153827, I diſpoſe of the Numbers as is before directed, and as you ſee in the Margin; then I begin, ſaying, 7, from 3 I cannot, but (adding 10 thereto I ſay) 7 from 13 and there remains 6. which I ſet under the Line in order; then I proceed to the next Figure, ſaying 1 that I borrowed and 2 is 3 from 0 I cannot, but 3 from 10 and there remains 7, which I likewiſe ſet down as before; then 1 that I borrowed and 8 is 9 from 5 I cannot, but 9 from 15 and there remains 6; then 1 I borrowed and 3 is 4 from 7 and there remains 3; then 5 from 3 I cannot, but 5 from 13 and there remains 8; then 1 I borrowed and 1 are 2 from 4 and there reſts 2; and thus the Work is finiſhed: And after theſe Numbers are ſubtracted one from the other the Inequality, Remainder, Exceſs, or Difference, is found to be 283676. Examples for thy further Experience may be theſe that follow.

	437503
	153827
	283676

From	3475016	From	3615746
Take	738642	Take	3615746
Reſt	2736374	Reſts	0000000

6. If the *Sum* or *Numbers* to be ſubtracted, are of ſeveral Denominations, place the leſſer *Sum* below the greater and in the ſame Rank and Order as is ſhewed in Addition of the ſame *Numbers*; then begin at the right Hand and take the lower *Number* out of the uppermoſt if it be leſſer; but if it be bigger than the uppermoſt, then borrow an Unit from the next greater

Deno-

Denomination, and turn it into the Parts of the less Denomination, and add those parts to the uppermost Number, and from their *Sum* subtract the lowermost noting the remainder below the Line; then proceed and pay 1 to the next Denomination for that which you borrowed before, and proceed in this Order until the Work be finished. An Example of this Rule may be this that followeth, let 375l. 13s. 07d. 1qr. be given, from whence let it be required to subtract 57l. 16s. 03d. 2qrs. In order whereunto I place the Numbers as you see in the Margin, and thus I begin at the least Denomination, saying, Two from One I cannot; therefore I borrow One Penny from the next Denomination, and turn it into Farthings, which is 4, and adding 4 to 1, which is 5, I say, but 2 from 5 and there remains 3, which I put under the Line; then going on, I say, 1 that I borrowed and 3 is 4, from 7 and there rests 3; then going on, I say 16 from 13 I cannot, (but borrowing one pound and turning it into 20 Shillings I add it to 13, that is 33) wherefore I say, 16 from 33, and there remains 17, which I set under the Line and go on, saying 1 that I borrowed and 7 is 8, from 5 I cannot, but 8 from 15 and there remains 7; the 1 that I borrowed and 5 is 6, from 7 and there rests 1 and 0 from 3 rests 3, and the Work is done: And I find the Remainder or Difference to be 317l. 17s. 03d. 3qrs.

l.	s.	d.	qrs.
375	13	07	1
57	16	03	2
317	17	03	3

Another Example of *Troy-Weight* may be this, I would subtract 17l. 10 oz. 11 p. w. 20 gr. from 24l. 05 oz. 00 p. w. 08 gr. I place the Numbers according to the Rule, and begin, saying, 20 from 8 I cannot, but borrow 1 *Penny-Weight*, which is 24 *Grains*, add them to 8, and they are 32, wherefore I say 20 from 32 rest 12, then 1 that I borrowed and 11 are 12, from 00 I cannot, but 12 from 20 (borrowing an Ounce which

l.	oz.	p.w.	gr.
24	05	00	08
17	10	11	20
06	06	08	12

is 20 *Penny Weight*) and there remains 8, then 1 that I borrowed and 10 is 11, from 9 I cannot but 11 from 17 and there rests 6; then 1 that I borrowed and 7 is 8, from 4 I cannot, but 8 from 14 and there rests 6; then 1 that I borrowed and 1 is 2 from 2 and there rests nothing; so that I find the Remainder or Difference to be 6l. 6 oz. 8 p. w. 12 gr.

7. It many Times happeneth that you have many *Sums* or *Numbers* to be *subtracted* from one *Number*; as suppose a Man should lend his Friend a certain Sum of Money, and his Friend hath paid him part of his Debt at several Times, then before you can conveniently know what is still owing, you are to add the several *Numbers* or *Sums* of Payment together, and *subtract* their *Sum* from the whole Debt, and the remainder is the *Sum* due to the Creditor, as suppose A lendeth to B 564l. 13s. 6d. and B hath repaid him 79l. 16s. 08d. at one time, and 163l. 18s. 11d. at another time, and 241l. 15s. 08d. at another time; and you would know how the Accompt standeth between them, or what is more due to A. In order whereunto First set down the *Sum* which A lent, and draw a line underneath it, then under that line set the several *Sums* of Payment as you see in the Margin; and having brought the several Sums of Payment into One Total by the Fifth Rule of the fourth Chapter foregoing, I find their Sum amounteth to 485l. 11s. 3d. which I subtract from the Sum first lent by A by the Sixth Rule of this Chapter, and I find the remainder to be 79l. 02s. 3d. and so much is still due to A.

	l.	s.	d.
Lent	564	13	6
Paid at several payments	79	16	08
	163	18	11
	241	15	08
Paid in all	485	11	03
Remains	79	02	03

When the Learner hath good Knowledge of what hath been already delivered in this and the foregoing Chapter, he will with Ease understand the manner of Working the following Examples.

Subtraction of Money.

	l.	s.	d.	l.	s.	d.	qrs.
Borrowed	374	10	03	700	10	11	2
Paid	69	15	11	9	03	11	3
Remains	304	14	04	691	06	11	3

	l.	s.	d.	l.	s.	d.	qrs.
Borrowed	1000	00	00	711	03	00	0
Paid	19	00	06	11	13	00	1
Remains	980	19	06	699	09	11	3

	l.	s.	d.	qrs.
Borrowed	3300	00	00	2
Paid at several Payments.	170	10	00	0
	361	13	10	1
	590	03	04	3
	73	04	11	3
Paid in all	1195	12	02	3
Remains due	2104	07	09	3

Subtraction of Troy-Weight.

	l.	oz.	p.w.	gr.
Bought	174	00	13	00
Sold	78	04	16	15
Remains	95	07	16	09

	l.	oz.	p. w.	gr
Bought	470	10	13	00
Sold at several Times.	60	00	00	00
	5	10	18	06
	16	07	09	08
	48	04	00	00
	61	11	19	23
	23	00	00	00
Sold in all	245	10	07	07
Rem. unsold	225	00	05	17

Subtraction of Apothecaries Weights.

	l.	oz.	dr.	sc.	gr	l.	oz.	dr.	sc.	gr.
Bought	12	04	3	0	00	20	00	1	0	07
Sold	8	05	1	1	15	10	00	1	2	12
Remains	3	11	1	1	05	9	11	7	0	15

Subtraction of Averdupois Weights

	C.	qrs.	l.	Tun	C.	qrs.	l.	oz.	dr.
Bought	25	00	15	15	07	01	10	10	05
Sold	16	22	20	03	17	01	16	09	13
Remains	08	01	23	11	09	03	22	00	08

Subtraction of Liquid Measure.

	Tuns	hhd.	gall.	Tun	hhd.	gall.	pint
Bought	40	1	30	60	3	42	4
Sold	16	1	40	15		46	6
Remains	2[illegible]	3	53	44	3	58	6

Subtraction of Dry Measure.

	Chal.	qrs.	bush.	pec.	Chal.	qrs.	bush.	pec.
Bought	100	0	00	0	73	2	3	2
Sold	54	1	04	3	46	2	3	3
Remains	45	2	03	1	26	3	7	3

Subtraction of Long Measure.

	yar.	qrs.	nail	yards	qrs.	nails
Bought	160	1	0	344	0	1
Sold	64	1	2	177	1	3
Remains	95		2	166	2	2

Subtraction of Land Measure.

	Acres	roods	per.	Acres	roods	perch.
Bought	140	2	13	600	0	00
Sold	70	3	22	54	0	16
Remains	69	2	31	545	3	24

The Proof of Subtraction.

8. When your *Subtraction* is ended, if you desire to prove your Work, whether it be true or no, then add the Remainder to the minor Number, and if the Aggregate of these Two be equal to the major Number, then is your Operation true, otherwise false; thus let us prove the first Example of the fifth Rule of this Chapter, where after Subtraction is ended, the Numbers stand as in the Margin; the remainder or difference being 283676. Now to prove the Work, I add the said Remainder 283676 to the minor number 153827 by the 4th Rule of the foregoing Chapter, and I find the Sum or Aggregate to be 437503 equal to the major Number, or Number from whence the lesser is Subtracted. Behold the Work in the Margin.

```
437503
153827
------
283676

437503
153827
------
283676
------
437503
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The

The Proof of another Example may be of the first Example of the sixth Rule of this Chapter, where it is required to be subtracted 57l. 16s. 03d. 2qrs. from 375l. 13s. 07d. 1qr. and by the *Rule* I find the *Remainder* to be 317l. 17s. d. 3qrs. now to prove it, I add the said *Remainder* 317l. 17s. 3d. 3qrs. to the minor number 57l. 16s. 03d. 2qrs. and their their Sum is 375l, 13s. 07d. 1qr. equal to the major *Number*, which proves the Work to be true, but if it had happened to have been either more or less than the said major *Number*, then the Operation had been false.

l.	s.	d.	qrs.
375	13	07	1
57	16	03	2
317	17	03	3
375	13	07	1

9. The general Effect of *Subtraction* is to find the Difference or Excess between two *Numbers*, and the Rest when a payment is made in part of a greater Sum, the Date of Books printed, the Age of any thing by knowing the present Year, and the Year wherein they were Made, Created or Built, and such like.

The Questions appropriated to this Rule are such as follow.

Quest. 1. What Difference is there between one thing of 125 Foot long, and another of 66 Foot long?

To resolve this Question, I first set down the major or greater Number 125, and under it the minor or lesser Number *66*, as is directed in the third *Rule* of this Chapter, and according to the fourth *Rule* of the same, I subtract the minor from the major, and the Remainder, Excess or Difference, I find to be 59. See the Work in the Margin.

125
66
59

Quest. 2. A Gentleman oweth a Merchant, 365l. whereof he hath paid 278l. what more doth he owe?

To

To give an *Answer* to this *Question*, I first set down the major Number 365l. and under it I place 278 the minor, and subtract the one from the other, and thereby I discover the Excess, Difference or Remainder to be 87 and so much is still due to the Creditor; as *per* Margin.

365
278
———
87
———

Quest. 3. An Obligation was written, a Book printed, a Child born, a Church built, or any other thing, made in the Year of our Lord 1572, and now we account the Year of our Lord 1735, the Question is to know the Age of the said things, that is, how many Years are passed since the said Things were made? I say if you subtract the lesser Number 1572, from the greater 1735, the Remainder will be 163, and so many Years are past since the making of the said Things, as by the Work in the Margin.

1735
1572
———
163
———

Quest. 4. There are three Towns lye in a strait line, *viz.* *London*, *Huntington* and *York*, now the Distance between the farthest of these Towns, *viz.* *London* and *York* is 151 Miles, and from *London* to *Huntington* is 49 Miles, I demand how far it is from *Huntington* to *York*.

To resolve this *Question*, subtract 49 the Distance between *London* and *Huntington*, from 151 the Distance between *London* and *York*, and the Remainder is 102, for the true Distance between *Huntington* and *York*. See the Work in the Margin.

151
49
———
102

CHAP. VI.

Of Multiplication of Whole Numbers.

1. Multiplication is performed by two Numbers of like Kind for the Production of a 3d which shall have such Reason to the one, as the other hath to an Unit, and in effect is a most brief and artificial com-

compound *Addition* of many equal Numbers of like Kind into one Sum. Or *Multiplication* is that by which we multiply two or more Numbers, the one into the other, to the end that their Product may come forth, or be discovered.

Or, *Multiplication* is the Increasing of any one Number by another; so often as there are Units in that Number, by which the other is increased or by having two Numbers given to find a third which shall contain one of the Numbers as many times as there are Units in the other.

2. *Multiplication* hath three Parts, first the *Multiplicand* or *Number* to be *multiplied*. Secondly, the *Multiplier*, or *Number* given, by which the *Multiplicand* is to be *multiplied*. And thirdly, the *Product* or *Number* produced by the other two. the one being multiplied by the other, as if 8 were given to be multiplyed by 4, I say 4 times 8 is 32, here 8 is the *Multiplicand*, and 4 is the *Multiplier*, and 32 is the *Product*.

$$\begin{array}{r} 8 \\ 4 \\ \hline 32 \end{array}$$

3. *Multiplication*, is either single by one Figure; or compound, that consists of many.

Single Multiplication is said to consist of one Figure, because the Multiplicand and Multiplier consist each of them of a Digit, and no more so that the greatest Product that can arise by single Multiplication is 81, being the Square of 9; and Compound Multiplication is said to consist of many Figures, because the Multiplicand or Multiplier consists of more Places than one; as if I were to multiply 436 by 6, it is called Compound, because the Multiplicand 436 is of more Places than one, *viz.* 3 Places.

4. The Learner ought to have all the Varieties of single Multiplication by Heart before he can well proceed any further in this Art, it being of most excellent Use, and none of the following Rules in Arithmetick but what have their principal Dependance thereupon, which may be learnt by the following Table.

Mul-

Multiplication Table,

1	2	3	4	5	6	7	8	9
2	4	6	8	10	12	14	16	18
3	6	9	12	15	18	21	24	27
4	8	12	16	20	24	28	32	36
5	10	15	20	25	30	35	40	45
6	12	18	24	30	36	42	48	54
7	14	21	28	35	42	49	56	63
8	16	24	32	40	48	56	64	72
9	18	27	36	45	54	63	72	81

The Use of the preceding Table is this, In the uppermost Line or Column you have expressed all the Digits from 1 to 9; and likewise beginning at 2 and going downwards in the side Column you have the same; so that if you would know the Product of any two single Numbers multiplied by one another, look for one of them, (which you please) in the uppermost Column, and for the other in the side Column, and running your Eye from each figure along the respective Column in the common Angle (or Place) where these two Columns meet, there is the Product required. As for Example, I would know how much is 8 times 7; first, I look for 8 in the uppermost Column, and 7 in the side Column; then do I cast my Eye from 8 along the Column, downwards from the same, and likewise from 7 in the side Column, I cast my Eye from thence towards the Right Hand, and find it to meet with the first Column at 56, so that I conclude 56 to be the Product required it would have been the same if you had looked for 7 in the Top, and 8 on the side, the like is to be understood of any other such Numbers. The Learner being perfect herein, it will be necessary to proceed.

5. In compound *Multiplication*, if the *Multiplicand* consists of many Places, and the *Multiplier* of but one figure; first

first set down the *Multiplicand*, and under it place the *Multiplier* in the Place of Units, and draw a Line underneath them; then begin and multiply the *Multiplier* into every particular figure of the *Multiplicand*, beginning at the place of Units, and so proceed towards the Left Hand, setting each particular Product under the Line in order as you proceed, but if any of the Products exceed 10 or any Number of Tens, set down the Excess, and for every 10 carry a Unit to be added to the next Product, always remembering to set down the Total Product of the last figure which Work being finished, the Sum or Number placed under the Line shall be the true and Total Product required. As for Example, I would multiply 478 by *6*. first I set down 478 and underneath it *6* in the Place of Units and draw a Line underneath them as in the Margin, then I begin saying *6* times 8 is 48, which is 8 above 4 Tens, therefore I set down 8 (the Excess) and bear 4 in mind for the 4 Tens, then I proceed, saying, *6* times 7 is 42, and 4 that I carried is 46, I then set down 6 and carry 4, and then go on saying 6 times 4 is 24, and 4 that I carried is 28, and because it is the last figure, I set it all down, and so the Work is finished, and the Product is found to be 2868, as was required.

478
6
2868

6. When in compound Multiplication the Multiplier consisteth of divers Places then begin with the figure in the place of Units in the Multiplier, and multiply it into all the figures in the Multiplicand, placing the Product below the Line as was directed in the last Example; and begin with the figure of the 2d Place of the Multiplier, *viz.* the Place of Tens, and Multiply it likewise into the whole Multiplicand (as you did the first figure) placing its Product under the Product of the first figure, do in the same manner by the 3d, 4th, and 5th, *&c.* until you have multiplied all the figures of the Multiplier particularly into the whole Multiplicand, still placing the Product of each particular figure under the Product of

of its preceding figure; herein obſerving the following Caution.

A Caution. In the placing of the Product of each particular figure of the Multiplier, you are not to follow the 2d Rule of the 4th Chapter, *viz.* not to place Units under Units and Tens under Tens, *&c.* but to put the Figure or Cypher in the Place of Units of the 2d Line under the 2d figure or Place of the Tens in the Line above it, and the figure or Cypher in the Place of Units of the 3d Line under the Place of Tens in the 2d Line, *&c.* Obſerving this Order till you have finiſhed the Work, *viz.* ſtill placing the firſt figure of every Line or Product under the 2d figure or Place of Tens in that which was above it and having ſo done, draw a Line under all theſe particular Products, and add them together; ſo ſhall the Sum of all theſe Products be the total Product required.

As if it were required to multiply 764 by 27, I ſet them down the one under the other with a line drawn underneath them; I begin, ſaying 7 times 4 is 28, then I ſet 8 and carry 2, then ſay 7 times 6 is 42, and 2 that I carried is 44, that is 4 and go 4, then 7 times 7 is 49, and 4 that I carry is 53 which I ſet down, becauſe I have not another Figure to multiply; thus have I done with the 7; then I begin with the 2, ſaying, 2 times 4 is 8. which I ſet down under (4) the ſecond Figure, or Place of Tens, in the Line above it, as you may ſee in the Margin: Then I proceed, ſaying 2 times 6 is 12: that is two and carry one, then 2 times 7 is 14. and 1 that I carry is 15, which I ſet down becauſe 'tis the Product of the laſt Figure; ſo that the Product of 764 by 7 is 5348, and by 2 is 1528, which being placed the one under the other, as before is directed and as you ſee in the Margin, and a Line drawn under them, and they added together reſpectively, make 20628 the true Product required, being equal to 27 times 764.

```
  764
   27
-----
 5348
1528
-----
20628
```

Another Example may be this; Let it be required to multiply 5486 by 465, I dispose of the Multiplicand and Multiplier, according to the Rule, and begin multiplying the first Figure of the Multiplier, which is five into the whole Multiplicand, and the Product is 27430; then I proceed and multiply the second Figure (6) of the Multiplier into the Multiplicand, and find the Product to amount to 32916, which is subscribed under the other Product respectively, then do I multiply the third and last Figure (4) of the Multiplier into the Multiplicand, and the Product is 21944, which is likewise placed under the second Line respectively; then I draw a Line under the said Products (being placed the one under the other according to this Rule) and add them together, and the Sum is 2550990, the true Product sought, being equal to 5486 times 465, or 465 times 5486.

```
   5486
    465
-------
  27430
 32916
21944
-------
2550990
```

More Examples in this Rule are these following.

```
   430865             6400758
     4739               37496
---------        ------------
  3877785            38404548
 1292595            57606822
3016055            25603032
1723460           44805306
----------       19202274
2041869235       ------------
                 240002821968
```

Compendium's in Multiplication.

7. Although the former Rules are sufficient for all Cases in Multiplication, yet because in the Work of Multiplication many times great labour may be saved, I shall acquaint the Learner with some Compendiums in order thereto, viz. If the Multiplicand or Multiplier, or both of them end with Cyphers, then

Si à numeris propositis unus vel uterque, adjunctos, habet ad dextram circulos; omissis circulis fiat ipsorum numerorum multiplicatio, & facto dextrorsum adscribantur tot circuli, quot sunt omissi circuli in utroque factore. Clavis Math. c. 4. 3.

then in your multiplying you may neglect the Cyphers, and multiply only the significant Figures, and to the Product of those significant Figures, add so many Cyphers as the Numbers given to be multiplied did end with; that is, annex them on the Right-hand of the said Product, so shall that give you the true Product required. As if I were to multiply 32000 by 4300, I set them down in order to be multiplied as you see in the Margin, but neglecting the Cyphers in both Numbers I only multiply 32 by 43. and the Product I find to be 1376, to which I annex the 5 Cyphers that are in the Multiplicand and Multiplier, and then it makes 137600000 for the true Product of 32000 by 4300.

```
    32000
     4300
---------
       96
      128
---------
137600000
```

8. If in the Multiplier Cyphers are placed between significant Figures, then multiply only by the significant Figures neglecting the Cyphers, but here special Notice is to be taken of the true Placing of the first Figure after the Neglect of such Cypher or Cyphers; and therefore you must observe in what Place of the Multiplier the Figure you multiply by standeth, and set the first Figure of that Product under the same Place of the Product of the first Figure of your Multiplier: As for Example, let it be required to multiply 371568 by 40007; first I multiply the Multiplicand by 7, and the Product is 2600979, then neglecting the Cyphers I multiply by 4, and that Product is 1486272, now I consider that 4 is the fifth Figure in the Multiplier, therefore I place 2 (the first Figure of the Product by 4) under the fifth Place of the first Product by 7, and the rest in Order, and having added them together, the total Product is found to be 14865320976.

Si intermedii multiplicantis lo- cinculus fuerit, illi negligantur. Alsted. chap. 9. de Arithm.

```
     371568
      40007
-----------
    2600976
1486272
-----------
14865320976
```

Other Examples in this Rule are these following.

371568

```
   327586          7864371
     6030            20604
 ---------      -----------
   9827580        31457484
 1965516        47186226
 ---------     15728742
1975343580     ---------------
               162037500084
```

9. If you are to multiply any Number by an Unit with Cyphers, (*viz.*) by 10, 100, 1000, *&c.* then annex so many Cyphers before the Multiplicand, that Number when the Cyphers are annexed, is the Product required; as if you would multiply 428 by 100, annex two Cyphers to 428 and it is 42800: If it were required to multiply 102 by 10000, annex 4 Cyphers and it gives 1020000 for the Product required.

The Proof of Multiplication.

10. Multiplication is proved by Division, and to speak truth all other Ways are false; and therefore it will be most convenient in the first Place, to learn Division, and by that to prove Multiplication. There is a Way (at this Day generally used in Schools) to prove Multiplication, which is this, first add all the Figures in the Multiplicand together, as if they were simple Numbers, casting away the Nines as often as it comes to so much, and noting the Remainder at last, which in this Case cannot be so much as 9: Cast likewise the Nines out of the Multiplier as you did out of the Multiplicand, and note that Remainder; then multiply the Remainders, the one by the other, and cast the Nines out of that Product, observing the Remainder; and lastly cast the Nines out of the total Product, and if this Remainder be equal to the Remainder last found, then they conclude the Work to be rightly performed; but there may be given a thousand (nay infinite) false Products in a Multiplication, which after this Manner may be

Non est quod alium expectes examinandi viam; namalia vulgares & falsa sunt, & nullo innixa fundamento.
Gemma Frisius.

pro-

proved to be true, and therefore this Way of proving doth not deserve any Example: but we shall defer the Proof of this Rule till we come to prove Division, and then we shall prove them both together.

11. The General Effect of Multiplication is contained in the Definition of the same, which is to find out a third Number, so often containing one of the two given Numbers as the other containeth Units.

The 3d Effect is by having the Length and Breadth of any thing (as a Parallellogram, or long Plane) to find the superficial Content of the same, and by having the superficial Content of the Base, and the Length to find out the Solidity of any Parallelipipedon, Cylinder or other solid Figure.

The 3d Effect is by the Contents, Price, Value, Buying, Selling, Expence, Wages, Exchange, simple Interest, Gain or Loss of any one thing, be it Money, Merchandize, &c. to find out the Value, Price, Expence, Buying, Selling, Exchange, or Interest of any Number of Things of like Name, Nature and Kind.

The 4th Effect is not much unlike the other by the Contents, Value, or Price of one Part of any thing denominated, to find out the Content, Value, or Price of the whole Thing, all the Parts into which the Whole is divided, multiplying the Price of one of those Parts.

The 5th Effect is, to aid to compound, and to make other Rules, as chiefly the Rule of Proportion called the Golden Rule, or Rule of Three; also by it, Things of one Denomination are reduced to another.

If you multiply any Number of Integers by the Price of the Integer, the Product will discover the Price of the Quantity or Number of Integers given.

In a Rectangular Solid if you multiply the Breadth of the Base by the Depth, and that Product by the Length, this last Product will discover the Solidity or Content of the same Solid.

Some Questions proper to this Rule may be these following.

Quest. 1. What is the Content of a square Piece of Ground, whose Length is 28 *Perches*, and Breadth 13 *Perches*?

Answer, 364 square *Perches*, for multiplying 28 the Length by 13 the Breadth, the Product is so much.

Quest. 2. There is a square Battle whose Flank is 47 Men and the Files 19 deep, what Number of Men doth that Battle contain? *Facit* 893; for multiplying 47 by 19 the Product is 893.

Quest. 3. If any one Thing cost 4 Shillings, what shall 9 such Things cost? *Answ.* 36 Shillings; for multiplying 4 by 9 the Product is 36.

Quest. 4. If a Piece of Money or Merchandize be worth or cost 17 Shillings, what shall 19 such Pieces of Money or Merchandize cost? *Facit* 323 Shillings, which is equal to 16l. 3s.

Quest. 5. If a Soldier or Servant get or spend 14s. *per* Month, what is the Wages or Charges of 49 Soldiers or Servants for the same Time? Multiply 49 by 14, the Product is 686s. or 34l. 6s. for the Answer.

Quest. 6. If in a Day there are 24 Hours how many Hours are there in a Year accounting 365 Days to constitute the Year? *Facit* 8760 Hours; to which if you add the 6 Hours over and above 365 Days, as there is in a Year, then it will be 8766 Hours; now if you multiply this 8766 by 60, the Number of Minutes in an Hour it will produce 525960 for the Number of Minutes in a Year.

CHAP. VII.

Of Division of whole Numbers.

DIVISION is the separating or parting of any Number or Quantity given into any Parts assigned; or to find how often one Number is contained in another: Or from any two Numbers given to find a third that shall consist of so many Units, as the one of those two given Numbers is comprehended or contained in the other.

1. Division hath three Parts or Numbers remarkable, *viz.* First, the Dividend, Secondly, the Divisor, Thirdly, the

the Quotient. The Dividend is the Number given to be parted or divided. The Divisor is the Number given; by which the Dividend is divided. Or it is the Number which sheweth how many Parts the Dividend is to be divided into and the Quotient is the Number produced by the Division of two given Numbers, the one by the other.

So 12 being given to be divided by 3, or into three equal Parts the Quotient will be 4, for 3 is contained in 12 four times, where 12 is the Dividend, and 3 is the Divisor, and 4 is the Quotient.

3. In Division set down your Dividend, and draw a crooked Line at each End of it, and before the Line at the Left-hand, place the Divisor, and behind that on the Right-hand, place the Figures of the Quotient, as in the Margin, where it is required to divide 12 by 3: First, I set down 12 the Dividend, and on each Side of it do I draw a crooked Line, and before that on the Left-hand do I place 3 the Divisor; then do I seek how often 3 is contained in 12, and because I find it 4 times, I put 4 behind the crooked Line on the Right-hand of the Dividend, denoting the Quotient.

3) 12 (4

4. But if when the Divisor is a single Figure, the Dividend, consisteth of two or more Places, then (having placed them for the Work as is before directed) put a Point under the first Figure on the left Hand of the Dividend provided it be bigger than or equal to the Divisor, but if it be lesser than the Divisor, then put a Point under the 2d Figure from the left Hand of the Dividend which Figures as far as the Point goeth from the left Hand are to be reckoned by themselves, as if they had no Dependance upon the other Part of the Dividend, and for Distinction sake may be called the Dividual, then ask how often the Divisor is contained in the Dividual, placing the Answer in the Quotient; then multiply the Divisor by the Figure that you placed in the Quotient, and set the Product thereof under the Dividual; then draw a Line under that Product, and subtract the said Product from the Dividual, placing the

the Remainder under the said Line, then put a Point under the next Figure in the Dividend, on the Right-hand of that which you put the Point before, and draw it down placing it on the Right-hand of the Remainder, which you found by Subtraction; which Remainder with the said Figure annexed before it shall be a new Dividual; then seek again how often the Divisor is contained in this new Dividual; and put the Answer in the Quotient on the Right-hand of the Figure which you put there before, then multiply the Divisor by the last Figure that you put in the Quotient, and subscribe the Product under the Dividual, and make Subtraction, and to the Remainder draw down the next Figure from the grand Dividend, (having first put a Point under it) and put it on the Right-hand of the Remainder for a new Dividual as before *&c.* and proceed thus till the Work is finished.

Observing this general Rule in all Kinds of Division first to seek how often the Divisor is contained in the Dividual; then (having put the Answer in the Quotient) multiply the Divisor thereby, and subtract the Product from the Dividual. An Example or two will make the Rule plain. Let it be required to divide 2184 by 6. I dispose of the Numbers given as is before directed, and as you see in the Margin, in order to the Work; then (because 6 the Divisor is more than 2 the first Figure of the Dividend) I put a Point under 1 the second Figure, which makes 21 for the Dividual, then do I ask how often 6 the Divisor is contained in 21, and because I cannot have it more than 3 times, I put 3 in the Quotient, and thereby do I multiply the Divisor (6) and the Product is 18, which I set in Order under the Dividual and subtract it therefrom, and the Remainder 3 I place in Order under the Line, as you see in the Margin.

6)2184(

6)2184(3
 •
18
——
 3

Then

Then do I make a Point under the next Figure of the Dividend, being 8, & draw it down, placing it before the Remainder 3, so have I 38 for a new Dividual, then do I seek how often 6 is contained in 38, and because I cannot have more than 6 times, I put 6 in the Quotient, and thereby do I multiply the Divisor 6, and the Product (36) I put under the Dividual (38) and subtract it therefrom, and the Remainder 2 I put under the Line as you see in the Margin.

```
6)2184(36
  ..
  18
  ----
   38
   36
  ----
    2
```

Then do I put a Point under the next (and last) Figure of the Dividend (being 4) and draw it down to the Remainder 2, and putting it on the Right-hand thereof, it maketh 24 for a new Dividual; then I seek how often 6 is contained in 24 and the Answer is 4, which I put in the Quotient, and multiply the Divisor (6) thereby; and the Product (24) I put under the Dividual (24) and subtract it therefrom, and the Remainder is 0, & thus the Work is finished, and I find the Quotient to be 364, that is, 6 is contained in 2184 just 364 times, or 2184 being divided into 6 equal Parts, 364 is one of those Parts.

```
6)2184(364
  ...
  18
  ----
   38
   36
  ----
    24
    24
  ----
   (0)
```

Again, If it were required to divide 2646 by 7 or into 7 equal Parts, the Quotient would be found to be 378, as by the following Operation appeareth.

```
7)2646(378
  ...
  21
  ----
   54
   49
  ----
    56
    56
  ----
   (0)
```

F Se

So if it were required to divide 946 by 8, the Quotient will be found to be 118, and the 2 remaining after Division is ended. The Work followeth.

8) 946 (118
8
―
14
8
―
66
64
―
(2)

Many times the Dividend cannot exactly be divided by the Divisor, but something will remain, as in the last Example, where 946 was given to be divided by 8, the Quotient was 118 and there remaineth 2 after the Division is ended: Now what is to be done in this Case with the Remainder, the Learner shall be taught when we come to treat of reducing (or Reduction) of Fractions.

And here *Note* that if after your Division is ended, any thing do remain, it must be lesser than your Divisor, for otherwise your Work is not rightly perform'd.

Other Examples are such as follow.

8) 73464 (9183	9) 13758 (1528
72	9
14	47
8	45
66	25
64	18
24	78
24	72
(0)	(6)

5. But if the Divisor consisteth of more Places than one, then chuse so many Figures from the left Side of the Dividend for a Dividual as there are Figures in the Divisor, and put a Point under the farthest Figure of that Dividual to the Right-hand, and seek how often the first Figure on the left Side of the Divisor is contained in the first Figure on the left Side of the Dividual, and place the Answer in the Quotient and thereby multiply your Divisor, placing your Product under your Dividual, and subtract therefrom, placing the Remainder below the Line; then put a Point under the next Figure in the Dividend, and draw it down to the said Remainder, and annex it on the right Side thereof, which makes a new Dividual, and then proceed as before, till the Work is finished.

And if it so happen that after you have chosen your first Dividual (as is before directed) you find it to be lesser than the Divisor, then put a Point under a Figure more near to the Right hand, and seek how often the first Figure on the left Side of the Divisor is contained in the two first Figures on the left Side of the Dividual, and place the Answer in the Quotient, by which multiply the Divisor, and place the Product thereof in Order under the Dividual; and subtract it therefrom and proceed as before.

Always remembring, that (in all the Cases of Division) if after you have multiplied your Divisor by the Figure last placed in the Quotient, the Product be greater than the Dividual, then you must cancel that Figure in the Quotient, and instead thereof put a Figure lesser by an Unit (or one) and multiply the Divisor thereby, and if still the Product be greater than the Dividual, make the Figure in the Quotient yet lesser by an Unit and thus do, until your Product be lesser than the Dividual, or at the most equal thereto, and then make Subtraction, &c.

So if you would divide 9464 by 24, the Quotient will be found to be 394. I first put down the given

Numbers, as before is directed in the third Rule: Now because my Divisor consisteth of two Figures, I therefore put a Point under, the second Figure from the Left hand in my Dividend, which here is 4 wherefore I seek how often 2 the first Figure (on the left Side of the Divisor) is contained in 9 (the like first in the Dividual) the Answer is 4. which I put in the Quotient, and thereby multiply all the Divisors, and find the Product to be 96, which is greater than the Dividual 94, wherefore I cancel the 4 in the Quotient, and instead thereof I put 3 (an Unit lesser) and by it multiply the Divisor 34, and the Product is 72, which I subtract from 94 the Dividual, and the Remainder is 22, then do I make a Point under the next Figure 6 in the Dividend, and draw it down, and place it on the right Side of the Remainder 22, and it makes 226 for a new Dividual, now because the Dividual 226 consisteth of a Figure more than the Divisor, therefore I seek how often 2 (the first Figure of the Divisor is contain'd in 22 the two first Figures of Dividual) I say 9 times, wherefore I put 9 in the Quotient and thereby multiply the Divisor 24. the Product (216) I place under Dividual 226, and subtract it, and there remaineth 10.

```
          (3
24) 9464 (4
     .
    72
   ----
    22
```

```
24) 9464 (39
     ..
    72
   ----
    226
    216
   ----
     10
```

Then I go on and make a Point under the next and last Figure (4) in the Dividend, and draw it down to the Remainder 10. and it maketh 104, for a new Dividual, which is also a Figure more than the Divisor, and therefore I seek how often 2 is contained in 10, I answer 5 times but multiplying my Divisor by 5, the Product is 120, which is greater than the Dividual, and therefore I make it but 4, and by it multiply the Divisor and the Product is 96, which being placed under, and subtracted from the Dividual, there remaineth 8, and thus the whole Work of this Division is ended, and I find that 9464 being divided by 24,

or

or into 24 equal Parts, is found to be 394, as was said before, and the Remainder is 8, as you see in the Work following.

```
24) 9464 (394
    ....
    72
    ---
    226
    216
    ---
    104
     96
    ---
    (8)
```

Another Example may be this, Let there be required the Quotient of 1183653 divided by 385, first I dispose of the Numbers in order to their dividing and because 118 the three first Figures of the Dividend is lesser than the Divisor 385, I therefore make a Point under the fourth Figure, which is 3, and seek how often 3 (the first Figure of the Divisor) is contained in 11? The Answer is 3, which I put in the Quotient, and thereby multiply the Divisor 385; and the Product is 1155, which I subtract from the Dividual 1183, and there remains 28.

```
385)1183653(3
       .
    1155
    ----
```

Then (as before) I draw down the next Figure, which is 6, and place it before the Remainder 28, so have I 286 for a new Dividual, and because it hath no more Figures than the Divisor, I seek how often 3 (the first Figure in the Divisor) is contained in 2 (the first Figure of the Dividual) & the Answer is 0, for a greater Number cannot be contained in a lesser, wherefore I put 0, in the Quotient, and thereby (according to the 5th Rule) I should multiply my Divisor, but if I do the Product will be 0, and 0 subtracted from the Dividual

```
385) 1183653(30
        ..
     1155
     ----
      286
```

286, the Remainder is the same; wherefore I draw down the next Figure (5) from the Dividend and put it before the said Remainder 286, so have I 2865 for a new Dividual, and because it consisteth of four Places, (*viz.*) a Place more than the Divisor. I seek how often 3 (the first Figure of the Divisor) is contained in 28 (the 2 first Figures of the Dividual) and I say there is 9 times 3 in 28. but multiplying my whole Divisor (385) thereby I find the Product to be 3465. which is greater than the Dividual 2865 wherefore I choose 8 which is lesser by an Unit than 9 and thereby I multiply my Divisor 385, and the Product is 3080 which still is greater than the said Dividual wherefore I choose another Number yet an Unit lesser, *viz.* 7; and having multiplied my Divisor thereby, the Product is 2695, which is lesser than the Dividual 2865, wherefore I put 7 in the Quotient, and subtract 2695 from the Dividual 2865, and there remains 170, then I draw down the last Figure (3) in the Dividend, and place it before the said Remainder 170, and it makes 1703 for a new Dividual then (for the Reason abovesaid) I seek how often 3 is contained in 17, the Answer is 5, but multiplying the Divisor thereby, the Product is (1925) greater than the Dividual wherefore I say it will bear 4 (an Unit lesser) and by it I multiply the Divisor 385 and the Product is 1540. which is lesser than the Dividual, and therefore I put 4 in the Quotient, and subtract the said Product from the Dividual, and there remaineth 193, and thus the Work is finished, and I find that 1183653 being divided by 385, or into 385 equal Shares or Parts, the Quotient (or one of those Parts) is 3074, and besides there is 163 remaining.

```
385) 1183653 (307
     ...
     1155
     ----
      2865
      2695
      ----
      (170)
```

```
385)1183653(3074
    ....
    1155
    ----
     2865
     2695
     ----
      1703
      1540
      ----
      (163)
```

And

And thus the Learner being well versed in the Method of the foregoing Examples he may be sufficiently qualified for the dividing of any greater Sum or Number into as many Parts as he pleaseth; that is he may understand the Method of dividing by a Divisor, which consisteth of 4, or 5 or 6, or any greater Number of Places, the Method being the same with the foregoing Examples in every Respect.

Other Examples in Division.

27986) 835684790 (29860

55972

275964
251874

240907
223888

170199
167916

Remains (22830)

196374) 473986018 (2413

392748

812380
785496

268841
196374

724678
589122

Remains (135556)

So if you divide 47386473 by 58736, you will find the Quotient to be 806, and 45257 will remain after the Work is ended.

In like manner if you would divide 3846739204 by 483064 the Quotient will be 7963 and the Remainder after Division will be 100572.

Compendiums in Division.

1. IF any given Number be divided by another Number that hath Cyphers annexed on the right Side thereof, (omitting the Cyphers) you may cut off so many Figures from the Right hand of the Dividend as there are Cyphers before the Divisor, and let the remaining Numbers in the Dividend, be divided by the remaining Number or Numbers in the Divisor, observing this Caution, that if after your Division is ended any thing remain you are to annex thereto the Number or Numbers that were cut off from the Dividend; and such new-found Number shall be the Remainder. As for Example:

Et si Divisor adjunctos sibi habeat Circulos ad dextram omissis circulis & abscissis totidem ultimis Figuris dividendi in numeris reliquis fiat divisio, in fine autem divisionis restituendi sunt tum omissi circuli; tum figuræ abscissæ. Ought. Cla. Matth. cap. 5. 3.

Let it be required to divide 46658 by 400; now because there are two Cyphers before the Divisor, I cut off as many Figures from before the Dividend, *viz.* 58, so that then there will remain only 466 to be divided by 4. and the Quotient will be 116, and there will remain 2, to which I annex the two Figures (58) which were cut off from the Dividend and it makes 258 for the true Remainder, so that I conclude 46658 being divided by 400, the Quotient will be 116, and 258 remaineth after the Work is ended; as by the Work in the Margin.

```
4,00)466|58(116
     4
     --
     6
     4
     --
     26
     24
     --
     (258)
```

2. And

2. And hence it followeth that if the Divisor be (1) or an Unit with Cyphers annexed, you may cut off so many Figures from before the Dividend, as there are Cyphers in the Divisor, and then the Figure or Figures that are on the Left-hand, will be the Quotient, and those that are on the Right-hand will be the Remainder after the Division is ended: As thus, if 45783 were to be divided by 10, I cut off the last Figure (3) with a Dash thus (4578|3) and the Work is done, and the Quotient is 4578 (the Number on the Left-hand of the Dash) and the Remainder is 3 (on the Right-hand;) in like Manner if the same Number 45783 were to be divided by 100, I cut off 2 Figures from the End thus (457|83) and the Quotient is 457, and the Remainder is 83. And if I were to divide the same by 1000, I cut off 3 Figures from the End thus, (45|783) and the Quotient is 45, and 783 the Remainder, &c.

Divisurus quemcunque numerum per. 10. Aufer ex dextra parte unicam, eamque primam figuram: Reliquæ enim figuræ productum ostendunt, Ablatum Residuum, &c. Gem. Fris. Arth. pa. 1.

6. The general Effect of Division, is contained in the Definition of the same (that is) by having two unequal Numbers given to find a third Number in such Proportion to the Dividend, as the Divisor hath to Unit or 1, it also discovers what Reason or Proportion there is between Numbers, so if you divide 12 by 4, it quotes 3, which shews the Reason or Proportion of 4 to 12 is triple.

The second Effect is by the superficial Measure or Content, and the Length of any Oblong, Rectangular, Parallelogram, or Square Plane known, to find out the Breadth thereby: or contrariwise by having the Superficies, and Breadth of the said Figure, to find out the Length thereof. Also by having the Solidity and Length of a Solid, to find the Superficies of the Base, & e contra.

The third Effect is by the Contents, Reason, Price, Value, Buying, Selling, Expences, Wages Exchange, Interest, Profit or Loss of any Number of Things (be it

it Money, Merchandize, or what else) to find out the Contents, Reason, Price, Value, Buying, Selling, Expence, Wages, Exchange, Interest, Profit or Loss, of any one Thing of like Kind.

The fourth Effect is to aid, to compose, and to make other Rules but principally the Rule of Proportion, called the Golden Rule, or Rule of Three, and the Reduction of Money Weights, and Measures, of one Denomination into another, by it also Fractions are abbreviated by finding a common Measure. unto the Numerator and Denominator; thereby discovering commensurable Numbers.

If you divide the Value of any certain Quantity, by the same Quantity, the Quotient discovers the Rate or Value of the Integer, as if 8 Yards of Cloth cost *96* Shillings; if you divide (*96*) the Value or Price of the given Quantity, by (8) the same Quantity, the Quotient will be 12 which is the Price or Value of 1 of those Yards, *&* *e contra*.

If you divide the Value or Price of any unknown Quantity, by the Value of the Integer, it gives you in the Quotient that unknown Quantity whose Price is thus divided; as if 12 Shilling were the Value of 1 Yard, I would know how many Yards are worth *96* Shillings: Here if you divide (*96*) the Price or Value of the unknown Quantity, by (12) the Rate of the Integer, or one Yard, the Quotient will be 8, which is the Number of Yards worth *96* Shillings.

Some Questions answered by Division may be these following.

Quest. 1. If 22 Things cost *66* Shillings, what will 1, such Thing cost? *Facit* 3 Shillings; for if you divide *66* by 22, the Quotient is 3 for the Answer; so if 36 Yards or Ells of any Thing be bought or sold for 108l. how much shall 1 Yard or Ell be bought or sold for? *Facit* 3l. for if you divide 108l. by 36 Yards, the Quotient will be 3l. the Price of the Integer.

Quest. 2. If the Expence, Charges or Wages of 7 Years Amount to 868l. what is the Expence, Charges, or

or Wages of one Year? *Facit* 124l. for if you divide 868 (the Wages of 7 Years) by 7 (the Number of Years) the Quotient will be 124l. for the Answer, See the Work.

7) 868 (124
7
———
16
14
———
28
28
———
(0)

Quest. 3. If the Content of one Superficial Foot be 144 Inches, and the Breadth of a Board be 9 Inches, how many Inches of that Board in Length will make such a Foot? *Facit*, 16 Inches; for by dividing 144 (the Number of Square Inches in a Square Foot) by 9 (the Inches in the Breadth of the Board) the Quotient is 16 for the Number of Inches in Length of that Board to make a Superficial Foot.

9) 144 (16 Inches,
9
———
54
54
———
(0)

Quest. 4. If the Content of an Acre of Ground be 160 Square Perches, and the Length of a Furlong (propounded) be 80 Perches, how many Perches will there go in Breadth to make an Acre? *Facit*, 2 Perches; for if you divide 160 (the Number of Perches in an Acre) by 80 (the Length of the Furlong in Perches) the Quotient is 2 Perches; and so many in Breadth of that Furlong will make an Acre.

80)160(2 Perches.

160

(0)

Quest. 5. If there be 893 Men to be made up into a Battle, the Front consists of 47 Men, what Number must there be in a File? *Facit*, 19 deep in the File: For if you divide 193, the Number of Men, by 47, the Number in Front, the Quotient will be 19 File in Depth; the Work followeth;

47) 893 (19 deep in File.

47

423
423

(0)

Quest. 6. There is a Table whose Superficial Content is 72 Feet, and the Breadth of it at the End is 3 Feet, now I demand what is the Length of this Table? *Facit* 24Feet long; for if you divide 72, the Content of the Table in Feet, by 3 the Breadth of it, the Quotient is 24 Feet for the Length thereof, which was required. See the Operation as followeth;

3) 72 (24

6

12
12

(0)

The Proof of Multiplication and Division.

Multiplication and *Division* interchangeably prove each other; for if you would prove a Sum in *Division*, whether the Operation be right or no, Multiply the Quotient

tient by the Divisor; and if any thing remain after the Division was ended, add it to the Product, which Product, if your Sum was rightly divided, will be equal to the Dividend: And contrariwise, if you would prove a Sum in *Multiplication*, divide the Product by the Multiplier, and if the Work was rightly performed, the Quotient will be equal to the Multiplicand. See the Example where the Work is done and undone. Let 7654 be given to be multiplied by 3242, the Product will be 24814268, as by the Work appeareth.

```
      7654
      3242
    ------
     15308
    30616
   15308
  22962
  --------
  24814268
```

And then if you divide the said Product 24814268 by 3242 the Multiplier, the Quotient will be 7654, equal to the given Multiplicand.

```
3242) 24814268 (7654
          .. ..
      22694
      -----
       21202
       19452
       -----
        17506
        16210
        -----
         12968
         12968
         -----
          (0)
```

In like manner, to prove a Sum or Number in Division, if 24814268 were divided by 3242 the Quotient will be found to be 7654; then for Proof, if you multiply 7654 the Quotient by 3242 the Divisor, the Product will amount to 24814268. equal to the Dividend.

Or you may prove the last, or any other Example in Multiplication thus, *viz.* Divide the Product by the Multiplicand, and the Quotient will be equal to the Multiplier. See the Work.

```
      7654
      3242
    ------
     15308
    30616
   15308
  22962
  --------
7654) 24814268 (3242
  22962
  -----
   18522
   15308
   -----
    32146
    30616
    -----
     15308
     15308
     -----
      (0)
```

From whence there ariseth this Corollary, that any Operation in Division may be proved by Division; for if after your Division is ended, you divide the Dividend by the Quotient, the new Quotient thence arising will be equal to the Divisor of the first Operation; for Tryal whereof let the last Example be again repeated.

3242)

3242) 24814268 (7654

22694

21202
19452

17506
16210

12968
12968

(0)

For Proof whereof divide again 24814268 by the Quotient 7654, and the Quotient hence will be equal to the first Divisor 3242; see the Work.

7654) 24814268 (3242

22962

18522
15308

32146
30616

15308
15308

(0)

But in proving Division by Division, the Learner is to observe this following Caution, that if after his Division is ended there be any Remainder, before you go about to prove your Work, subtract that Remainder out of your Dividend, and then work as before, as in the following Example, where it is required to divide 43876 by 765, the Quotient here is 57, and the Remainder is 271; see the Work following

765) 43876 (57
3825
5626
5355
[271]

Now to prove this Work, subtract the Remainder 271 out of the Dividend 43876, and there remaineth 43605 for a new Dividend to be divided by the former Quotient 57, and the Quotient thence arising is 765 equal to the given Divisor, which proveth the Operation to be right.

43876
271
57) 43605 (765
399
370
342
285
285
[0]

Thus have we gone through the four Species of Arithmetick, *viz.* Addition, Subtraction, Multiplication, and Division; upon which all the following Rules and all other Operations whatsoever that are possible to be wrought by Numbers have their immediate Dependance and by them are resolved. Therefore before the Learner make a further Step in this Art, let him be well acquainted with what hath been delivered in the foregoing Chapters.

Hæ sunt igitur quatuor illæ species Arithmetices per quas omnia quæcunque deinceps dicenda sunt vel quæ per Numeros fieri possibile est, absolvuntur. Quare eas quisquis et ante omnia perdiscat. Gem. Fris. Arith. pag. 1.

CHAP.

CHAP. VIII.

Of Reduction.

1. REduction is that which brings together two or more Numbers of different Denominations into one Denomination; or it serveth to change or alter Numbers, Money, Weight, Measure or Time, from one Denomination to another, and likewise to abridge Fractions to their lowest Terms. All which it doth so precisely, that the first Proportion remaineth without the least Jot or Error or Wrong committed. So that it belongeth as well to Fractions as Integers, of which in its proper Place. Reduction is generally performed either by Multiplication or Division; from whence we may gather that.

Hills Arith C. 13. p. 152.

2. Reduction is either descending or ascending.

3. Reduction descending, is when it is required to reduce a Sum or Number of a greater Denomination, into a lesser; which Number, when it is so reduced, shall be equal in Value to the Number first given in the greater Denomination; as if it were required to know how many Shillings, Pence or Farthings are equal in Value to an Hundred Pounds? Or how many Ounces are contained in 45 Hundred Weight; or how many Days, Hours, or Minutes there are in 240 Years, &c. And this Kind of Reduction is generally performed by Multiplication.

Wing. Arith. Ch. 7. 2, 3, 4.

4. Reduction ascending, is when it is required to reduce or bring a Sum or Number of a smaller Denomination into a greater which shall be equivalent to the given Number; as suppose it were required to find out how many Pence Shillings or Pounds are equal in Value to 43785 Farthings; or how many Hundreds are equal to or in, 3748 Pounds, &c, and this Kind of Reduction is always performed by Division.

5. When a Sum or Number is given to be reduced into another Denomination, you are to consider whe-

ther it ought to be resolved by the Rule descending or ascending, *viz.* by Multiplication or Division: If it be to be performed by Multiplication, consider how many Parts of the Denomination into which you would reduce it, are contained in a Unit or Integer of the given Number, and multiply the said given Number thereby, and the Product thereof will be the Answer to the Question. As if the Question were, in 38 Pounds, how many Shillings? Here I consider, that in one Pound are 20 Shillings and that the Number of Shillings in 38 Pounds will be 20 times 38, where I multiply 38 by 20 and that Product is 760, and so many Shillings are contained in 38 Pounds, as in the Margin.

38
20
760

But when there is a Denomination, or Denominations between the Number given, and the Number required, you may if you please, reduce it into the next inferior Denomination, and then into the next lower than that, &c. until you have brought it into the Denomination requir'd: As for Example let it be demanded in 132 Pounds how many Farthings? First, I multiply 132, the Number of Pounds given by 20 to bring it into Shillings, and it makes 2640 Shillings, then do I multiply the Shillings 2640 by 12, to bring them into Pence, and it produceth 31680, and so many Pence are contained in 2640 Shillings, or 132 Pounds; then do I multiply the Pence, 31680 by 4 to bring them into Farthings, because 4 Farthings is a Penny, and I find the Product thereof to be 126720, and so many Farthings are equal in Value to 132 Pounds: The Work is manifest in the Margin.

132 *pounds.*
20
2640 *shillings.*
12
5280
2640
31680 *pence.*
4
126720 *farth.*

6. And if the Number propounded to be reduced, is to be divided, or wrought by the Rule Ascending, consider how many of the given Number are equal to an Unit or Integer, in that Denomination to which you would reduce your given Number and make that your Divisor; and the given Number your Dividend; and the Quotient thence arising will be the Number sought or required: As for Example, Let it be required to reduce 2640 Shillings into Pounds. Here I consider that 20 Shillings are equal to one Pound; wherefore I divide 2640, the given Number, by 20; and the Quotient is 132, and so many Pounds are contained in 2640 Shillings. In Reduction descending and ascending the Learner is advised to take particular Notice of the Tables delivered in the second Chapter of this Book, where he may be informed what Multipliers or Divisors to make use of in the reducing of any Number to any other Denomination whatsoever, especially *English* Moneys, Weights, Measures, Time, and Motion; but in this Place it is not convenient to meddle with Foreign Coins, Weights, or Measures.

```
           1
2|0) 264|0(132
       2
     -----
       6
       6
     -----
       4
       4
     -----
      [0]
```

But if in Reduction ascending it happen that there is a Denomination or Denominations between the Number given and the Number required, then you may reduce your Number given into the next superior Denomination, and when it is so reduced bring it into the next above that, and so on until you have brought it into the Denomination requir'd. As for Example.

Let it be demanded in 126720 Farthings, how many Pounds? First, I divide my given Number being Farthings, by 4, to bring them into Pence, because 4 Farthings make one Penny, and they are 31680 Pence then I divide 31680 Pence by 12, and the Quotient

giveth

giveth 2640 Shillings, and then I divide 2640 Shillings by 20, and the Quotient giveth 132 Pounds, which are equal in Value to 126720 Farthings. See the whole Work as it followeth.

```
           12]      2|0]   l.
4] 126720 [ 31680 [264|0 [132
   ......  ......  ...
   12       24      2
   --       --      --
    6       76      6
    4       72      6
   --       --      --
   27       48      4
   24       48      4
   --       --      --
    32      [0]     [0]
    32
    --
    [0]
```

7. When the Number given to be reduced, consisteth of divers Denominations, as Pounds, Shillings, Pence, and Farthings, or of Hundreds, Quarters, Pounds and Ounces, *&c.* then you are to reduce the highest, or greatest Denomination into the next inferior, and add thereunto the Number standing in that Denomination which your greatest or highest Number is reduced to; then reduce that Sum into the next inferior Denomination, adding thereto the Number standing in that Denomination; do so until you have brought the Number given into the Denomination propos'd. As if it were required to reduce 48l. 13s. 10d. into Pence; first, I bring 48l. into Shillings, by multiplying it by 20, and the Product is 960 Shillings to which I add the 13 Shillings and they make 973 then I multiply 973 by 12, to bring the Shillings into Pence, and they make 11676 Pence, to which I add the 10 Pence, and they make 11686 Pence for the Answer. See the Work done.

8. If

l. s. d.
48——13——10
20
———
960 *Shillings*
Add 13
———
Sum 973 *Shillings*
12
———
1946
973
———
11676 *Pence*
Add 10
———
Sum 11686 *Pence*

8. If in Reduction Ascending, after Division is ended, any Thing remain, such Remainder is of the same Denomination with the Dividend.

Example. In 4783 *Farth.* I demand how many *Pounds* ?

First, I divide the given Number of Farthings, *viz.* 4783, by 4 to bring them into Pence, and the Quotient is 1195 Pence, and there remaineth 3 after the Work of Division is ended, which is 3 Farthings.

Again, I divide 1195 Pence, the said Quotient, by 12, to reduce them into Shillings, and the Quotient is 99 Shillings, and there is a Remainder of 7, which is 7 Pence.

And then I divide 99 Shillings, the last Quotient, by 20, to bring it into Pounds, and the Quotient is 4l. and there remaineth 19 Shillings; so that I conclude that in 4783 the proposed Number of Farthings there is 4 Pounds, 19 Shillings, 7 Pence, 3 Farthings. View the following Operation.

4]4783

```
     12]   2|0
4] 4783 [1195 [9|9 [4 Pounds
   ....  ....   .
   4     108    8
  ---    ---   ---
   7     115 [19] Shillings
   4     138
  ---    ---
    38     [7] Pence
    36
   ---           l.   s.   d.   qrs
    23 Facit     4 — 19 — 7 —— 3
    20
   ---
Rem. [3] Farthings
```

More Examples in Reduction of Coin.

Quest. 1. In 438l. how many Shillings? *Facit* 8790 Shillings; for by multiplying 438 by 20 the Product amounteth to so much. See the Work.

```
      438 Pounds
       20
     ------
Facit 8760
```

Quest. 2. In 467l. how many Pence? First, multiply the given Number of Pounds, 467, by 20 to bring it into Shillings, and it makes 9340 Shillings, then multiply the Shillings by 12, and it produceth 112080 Pence, thus,

```
        467 Pounds
         20 Shillings
       ------
       9340
         12
       ------
      18680
      9340
      ------
Facit 112080 Pence
```

Or

Or it may be resolved thus, *viz.* multiply the given Number of Pounds 467 by 240 the Number of Pence in a Pound, and the Product is the same, *viz.* 112080 Pence, as by the Operation appeareth.

	467 *Pounds*
	240
	18680
	934
Facit	112080 *Pence*

Quest. 3. In 5673l. how many Farthings? First Multiply the given Number by 20, to bring it into Shillings, and it produceth 113460 Shillings, then multiply that Product by 12, to bring it into Pence, and it produceth 1361520 Pence; then lastly, multiply the Pence by 4, and it produceth 5446080 Farthings. See the Operation.

	5673 *Pounds*
	20
	113460 *Shillings*
	12
	226920
	113460
	1361520 *Pence*
	4
Facit	5446080 *Farthings.*

Or this Question might have been thus resolved *viz.* Multiply 5673, the given Number of Pounds, by 960, the Number of Farthings in a Pound, and it produceth the same Effect, as you may see by the Work.

5673

	5673 *Pounds*		20 *Shillings*
	960		12
	340380		240 *Pence*
	51057		4
Facit	5446080 *Farthings*		960 *Farthings*

Otherwise thus, First bring the given Number 5673l. into Shillings, and multiply the Shillings by 48, the Number of Farthings in a Shilling. and the same Effect is thereby likewise produced, *viz.*

	5673	12 *Pence*
	20	4
	113460 *Shillings*	48 *Farthings*
	48	
	907680	
	453840	
Facit	5446080 *Farthings*	

These various Ways of Operating are expressed to inform the Judgment of the Learner, with the Reason of the Rule; more Ways may be shewn, but these are sufficient even for the meanest Capacities.

Quest. 4. In 458l. 16s. 7d. 3qrs. how many Farthings? To resolve this Question consider the seventh Rule of this Chapter, and Work as you are there directed, and you will find the aforesaid given Number to amount to 440479 Farthings, *viz.*

l.	s.	d.	qrs.
458	16	7	3

20
9160 *Shillings*
Add 16
Sum 9176 *Shillings*
12
18352
9176
110112 *Pence*
Add 7
Sum 110119 *Pence*
4
440476 *Farth.*
Add 3
Sum 440479 *Farth.*

This last Question (or any other of this kind; *viz.* where the Number given to be reduced consisteth of several Denominations) may be more concisely resolved thus, *viz.* when you multiply the Pounds by 20, to bring them into Shillings, to the Product of the first Figure, add the Figure standing in the Place of Units in the Denomination of Shillings, but because the first Figure in the Multiplier is (0) I say 0 times 8 is nothing, But 6 is 6, which I put down for the first Figure in the Product, then because this Multiplier is 0, I go on no further with it, for if I should the whole Product would be 0, but proceed, and when I come to multiply by the second Figure in the Multiplier, and to the Product of it, I add the Figure standing in the Place of Tens in the Denomination of Shillings which is 1, saying 2 times 8 is 16, and

the ſaid Figure 1 is 17, then I ſet down 7, and carry an Unit to the Product of the next Figure, as is directed in the fifth Rule of the ſixth Chapter forgoing; and finiſh the Work. So that you now have the whole Product and Sum of Shillings at one Operation, which is the ſame as before, and when you multiply the Shillings by 12, to bring them into Pence, after the ſame manner, add to the Product the Number ſtanding in the Denomination of Pence, and ſo when you multiply the Pence by 4 to bring them into Farthings, add to the Product the Number ſtanding under the Denomination of Farthings. See the laſt Queſtion thus wrought.

l.	s.	d.	qrs.
458	16	7	3

20

9176 *Shillings*
12

18359
9176

110119 *Pence*
4

Facit 440479 *Farthings*

After the Method laſt preſcribed (which if rightly conſidered, differeth not any thing from the 7th Rule of this Chapter) are all the following Examples, that are of the ſame Nature wrought and reſolved.

Queſt. 5. In 4375866 Farthings, I demand how many Pounds, Shillings, and Pence.

To reſolve this Queſtion; Firſt I divide the given Number of Farthings by 4, and the Quotient is 1093966 Pence, and there remaineth 2 after the Diviſion is ended which by the 8th Rule foregoing, is 2 Farthings; then I divide 1093966 Pence by 12. and the Quotient is 91163 Shillings, and there remaineth 10 after Diviſion

viſion, which by the ſaid 8th Rule is ſo many Pence, *viz.* 10d. then I divide 91163 Shillings, by 20, and the Quotient is 4558l. and there remaineth 3 Shillings, ſo the Work is finiſhed, and I find that in 4375866 Farthings there are 4558l, 3s. 10d. 2qrs. See the Operation.

```
             12)           2|0)       l.
4)4375866 (1093966 (9116|3 (4558
  .......  ........ .....
    ...                 ..
  4          108       8
  ---        -----     ----
   37         13       11
   36         12       10
   ---        ---      ----
    15         19       11
    12         12       10
    ---        ---      ----
     38         76      16
     36         72      16
     ---        ---     ----
      26        46     (3) s.
      24        36
      ---       ---     ----
       26      (10) d.
       24
       ---
      (2) qrs.
```

	l.	s.	d.	qrs.
Facit	4558—	3—	10—	—2

Queſt. 6. In 4386l. I demand how many Groats?

To reſolve this Queſtion, I reduce the given Number of Pounds into Shillings, and they are 87720 Shillings, now I conſider that in a Shilling are 3 Groats, therefore I multiply the Shillings by 3, and it produceth 263160 Groats. See the Work.

4386 *Pounds*
20
87720 *Shillings*
3

Facit 263160 *Groats*.

This Question might have been otherwise resolved thus, *viz*. considering that in a Pound, or 20 Shillings, there are 3 times 20 Groats, which make 60, by which I multiply the Number of Pounds given, and it produceth the same Effect at one Operation, as followeth.

4386 *Pounds*	20
60 *Groats in* 20s	3
Facit 263160 *Groats in* 4386l.	60

Quest. 7. In 43758 Three-pences, I desire to know how many Pounds?

To resolve this and many such like Questions: First, I divide my given Number of Three-pences by 4, because 4 Three-pences are in a Shilling, and the Quotient is 10939 Shillings, and there remaineth 2 after Division is ended, which is 2 Three-pences (by the 8th Rule of this Chapter) which are equal in Value to 6d. then I divide 10939 Shillings by 20, and the quote giveth 546l. and 19s. remain; so that I conclude in 43758 Pieces Three-pence *per* Piece, there are 546l. 19s 6d. as by the Work appeareth.

```
            2|0        l.   s.   d.
4) 43758 (1093|9 (546 — 19 — 6
   .....    ....
   4        10
   ----    -----
   37       9
   36       8
   ----    -----
   15       13
   12       12
   ----    -----
   38      (19)s.
   36
   ----
```

(2) *Three-pences or 6d.*

This Question might have been otherwise resolved thus, *viz.* first multiply the given Number of Three-pences 43758, by Three the Number of Pence in Three-pence, and the Product (*viz.* 131274) is the Number of Pence equal to the given Number of Three-pences, which Number of Pence may be brought into Pounds by dividing by 12 and by 20, and the Quotient you will find to be equal to the former Work, *viz.* 546l. 19s. 6d.

```
     43758
         3
    ------  2|0)     l.    s.    d.
12) 131274 (1093|9 (546 — 19 — 6
    ......   ....
    12       10
    ----     ----
    112      9
    108      8
    ----     ----
     47      13
     36      12
    ----     ----
    114 re. (19) s.
    108
    ----
```

Remains (6) *Pence*

Or thus, divide the given Number of Three-pences by the Number of Three-penees in a Pound or 20 Shillings (which you will find to be 80, if you multiply 20 by 4, the Number of Three-pences in a Shilling) and you will find the Quote to be 546l. as before, and a Remainder of 78 Three-pences and if you divide those 78 Three-pences by 4, (because there are 4 Three-pences in a Shilling) you will find the Quote to be 19s. and 2 Three-pences remain, which are equal to 6d. which is the same that was before found.

```
                    l.      s.     d.
8|0) 4370|8 (546 —— 19 —— 6          20
     ...                              4
     40                              ——
     ——                              80
     37
     32
     ——
     55
     48
     ——
  4) 78 (19 s.
     ..
     4
     ——
     38
     36
     ——
     (2) Three-pences or 6 Pence.
```

Quest. 8. In 4785l. 19s. how many Pieces of 13½d. *per* Piece?

This Question cannot be resolved by Reduction descending or ascending absolutely, because 13½d. is no even part of a Pound, but rather by them both jointly, *viz.* by Multiplication and Division; for if you bring the Number given into Half-pence, and divide the Half-pence by the Half-pence in 13½d. *viz.* 27, the Quotient will be the Answer; for having brought

brought 4785l. 13s. into Half-pence, I find it makes 2297112, which I divide by 27, because there are so many Half-pence in 13½d. and the Quote gives 85078 Pieces of 13½d. and 6 Half-pense remain over and above; Observe the Work following.

```
 l.      s.                              d.
4785 —— 13                              13½
  20                                      2
——————                               ——————
95713 Shillings                      27 Half-pence
   24 Half-pence in a Shilling.
——————
 382852
191426
——————
2297112 Half-pence in the given Number.
   27) 2297112 (85078 Pieces of 13½d.
       .......
       216
       ———
        137
        135
        ———
          211
          189
          ———
           222
           216
           ———
Rem.   (6) Half-pence.
```

It would have produced the same Answer if you had reduced your given Number into Farthings, and divided by the Farthings in 13½d. *viz.* 54, for always the Dividend and the Divisor must be of one Denomination, and then you would have had a Remainder of 12 Farthings, which are equal in Value to the former.

mer Remainder of 6 Half-pence, as you may prove at your Leisure.

Quest. 9. In 540 Dollars at 4s. 4d. per Dollar, how many Pounds Sterl?

First, Bring your given Number of Dollars into Pence, and then your Pence into Pounds according to the former Directions. Thus in 4s. 4d. *viz*. a Dollar, you will find 52 Pence. by which multiply 540 Dollars, and it produceth 28080 Pence, which if you divide by 240. the Pence in one Pound, the Quotient will give you 117l. which are equal in Value to 540 Dollars, at 4s. 4d. per Dollar. Observe the Operation.

```
                         s.    d.
       540               4 ——— 4
        52               12
      ————              ————
      1080               52 Pence.
      2700
      ————   l.
 24|0)2808|0(117
      ...
      24
      ————
       40
       24
      ————
       168
       168
      ————
         0
```

The foregoing Question might have been otherwise wrought, thus, *viz*. Multiply 540 your given Number of Dollars, by 13 the Number of Groats in a Dollar, or 4s. 4d. and it produceth 7020 Groats, which divide by 60, the Groats in a Pound or 20 Shillings, and the Quote is 117l. as before. See the Work.

540

```
                  s.   d.
      540         4————4
       13         3
      ————       ————
     1620        13
      540
  ———————————————————
  6|0) 702|0(117l
        ..
        6
       ———
        10
         6
       ———
          42
          42
        ————
         (0)
```

Quest. 10. In 547386 Pieces of $4\frac{1}{2}$d. per Piece, I demand how many Pounds, Shillings, and Pence.

First, Bring your given Number of Four-pence-halfpennys all into Half-pence, which you will do if you multiply by 9, the Number of Half-pence in $4\frac{1}{2}$d. and the Product is 4926474 Half-pence, which are brought into Pounds, if you divide them by 24, the Half-pence in a Shilling, and 20 the Shillings in a Pound, it makes 10263l. 9s. 9d. as by the Work.

```
   547386                              d.
        9                              4½
   ------                              2
                2|0)              l.  --
24) 4926474(20525|9   (10263   9 Half pence
     ....   ...

   48        2
   ---      --
   126      05
   120       4
   ---      --
    64      12                 l.   s.  d.
    48      12      Facit 10263——9——9
   ---      --
   167       6
   144       6
   ---      --
    234     (9)s
    216
    ---
```

Remains (18) *Half-pence, or 9d.*

Quest. 11. In 4386l. I demand how many Pieces of 6d. of 4d. and of 2d. of each an equal Number? that is to say, what Number of Six-pences, Groats, and Two-pences, will make up 4386l. and the Number of each equal?

The Way to resolve Questions of this Nature, is to add the several Pieces (into which the given Number is to be brought) into one Sum, and to reduce the given Number into the same Denomination with their Sum, and to divide the said given Number, so reduced, by the said Sum, and the Quotient will give you the exact Number of each Piece. And after the same Method will we proceed to resolve the present Question, viz.

4386

4386 *Pounds*	6
240 *Pence*	4
	2
175440	
8772	*Sum* 12 *Pence*

12)1052640(87720
96
92
84
86
84
24
24
(0)

d. d. d.
Facit 87720 *Pieces of* 6—4—2

So that I conclude by the Operation that 87720 Sixpences, and 87720 Groats, and 87720 Two-pences are just as much as, or equal to, 4386l. or if you admit of 5s. to be thus divided, it is equal to 5 Six pences, and 5 Four-pences or Groats, and 5 Two-pences. *For if two right Lines, or two Numbers be given, and one of them be divided into as many Parts, or Segments as you please, the Rectangle, or Product comprehended under the two whole right Lines, or Numbers given, shall be equal to all the Rectangles, or Products, contained under the whole Line, or Number and the several Segments, or Parts, into which the other Line, or Number is divided.* Eucl. 2. 1.

Another Question of the same Nature with the last may be this following, *viz.*

Quest. 12. A Merchant is desirous to change 148l into Pieces of 13d $\frac{1}{2}$ of 12d. of 9d. of 6d. and of 4d; and he will have of each Sort an equal Number of Pieces, I desire to know the Number?

Do as you were taught in the last Question, *viz.* add the several Pieces together, and reduce the Sum into Half-

Half-pence, then reduce the Sum to be changed, *viz.* 148l. into the ſame Denomination; and divide the greater by the leſſer, and in the Quotient you will find the Anſwer, *viz.* 798 is the Number of each of the Pieces required, and 18 remaineth, which is 18 Half-pence by the 8th Rule of this Chapter. See the Work as followeth.

l.	d.
148	$13\frac{1}{2}$
240 *Pence in a Pound*	12
	9
5920	6
296	4
35520 *Pence in* 148l.	*Sum* $44\frac{1}{2}$
2	2
71040 *Half-pence*	89 *Half pence.*

89)71040 (798 *Pieces of each Sort.*

623

874
801

730
712

Remain (18) *Half pence*

The Truth of the two foregoing Operations will thus be proved *viz.* Multiply the Anſwer by the Parts, or Pieces into which the given Number was reduced, and having added the ſeveral Products together, if their Sum be equal to the given Number, the Anſwer is right, otherwiſe not.

So the Anſwer to the 11th Queſtion was 87720, which is proved as followeth, *viz.*

		l.
87720	*Sixpences make*	2193
	Fourpences make	1462
	Twopences make	731

The Total Sum of them 4386 *which was the Sum given to be changed.*

The Anſwer to the 12th Queſtion was 798, and 18 Halfpence remained after the Work was ended, now the Truth of the Work may be proved as the former was *viz.*

		l.	s.	d.
798	*Pieces of* $13\frac{1}{2}$ *make*	44	17	09
	Pieces of 12 *make*	39	18	00
	Pieces of 9 *make*	29	18	06
	Pieces of 6 *make*	19	19	00
	Pieces of 4 *make*	13	06	00
And 18 *Half pence or* 9d *remains*		00	00	09
	The Total Sum of them	148	00	00

which Total Sum is equal to the Number that was firſt given to be changed, and therefore the Operation was rightly performed.

Reduction of Troy Weight.

We come now to give the Learner ſome Examples in *Troy-Weight*, wherein we ſhall be brief, having given ſo large a Taſte of Reduction in the foregoing Examples of Coyn, and now the Learner muſt be mindful of the Table of *Troy-Weight* delivered in the 2d Chapter of this Book.

Queſt. 13. In 48l. 07 oz. 13 p.w. 21 gr. how many Grains ?

Multiply by 12, by 20, and by 24, taking in the Figures ſtanding in the ſeveral Denominations according to the Direction given in the 7th Rule of this Chapter, and you will find the Product to be 2780013 Grains, which is the Number required, or Anſwer to the Queſtion. See the whole Work as followeth.

l

48

```
  l.    oz.   p.w.   gr.
 482 —— 7 —— 13 —— 21
  12
 ----
 971
 482
 ----
 5791 ounces
   20
 ------
 115833 p.w.
     24
 ------
 463333
 231668
 -------
```

Facit 2780013 *grains.*

Quest. 14. In 2780013 grains, I demand how many Pounds, Ounces, Penny-Weights, and Grains?

This is but the foregoing Question inverted, and is resolved by dividing by 24 by 20, and by 12, and the Answer is 482l 7 oz. 13 p.w. 21 gr.

```
                 2|0)        12)     l.
 24) 2780013  (11583|3  (5791  (482
     .......     ....     ...
     24          10        48
     ---        ---       ---
      38          15        99
      24          14        96
     ---        ---       ---
      140          18        31
      120          18        24
      ---         ---       ---
       200          3 Rem. (7) ounces
       192          2
        81 Rem. (13) Penny-Weight
        72
        ---
        93     l.    oz.   p.w.   gr.
        72 Fac. 482 —— 7 —— 13 —— 21
        ---
 Remains (21) grains
```

Quest. 15. A Merchant sent to a Goldsmith 16 Ingots of Silver, each containing in Weight 2l, 4 oz. and ordered it to be made into Bowls of 2l 8 oz. per Bowl, and Tankards of 1l 6 oz. per Piece, and Salts of 10 oz. 10 p. w. per Salt, and Spoons of 1 oz. 18 p. w. per Spoon, and of each an equal Number, I desire to know how many of each sort he must make?

This Question is of the same Nature with the 11th and 12th Questions foregoing, and may be answered after the same Method: *viz.* First, add the Weight of the several Vessels (into which the Silver is to be made) into one Sum and reduce it to one Denomination and they make 1248 Penny-weights, then reduce the Weight of the Ingot into the same Denomination *viz.* Penny-weights, (and it makes 560 Penny-weights) and multiply them by the Number of Ingots, *viz.* 16, and the Product will give you the Weight of the 16 Ingots, *viz.* 8960, then divide this Product by the Weight of the Vessels, *viz.* 1248, and the Quotient giveth you the Answer to the Question, *viz.* 7. and 224 p. w. remaining over and above.

```
  l.       oz.                      l.    oz      p. w.
  2 ———— 4                          2 ——— 08 ———— 00
 12                                 1 ——— 06 ———— 00
 ———                                0 ——— 10 ———— 10
 28                                 0 ——— 01 ———— 18
 20                                 ————————————————
 ———                           Sum  5 ——— 02 ———— 08
 560  Penny-Weights                12
  16  Ingots                      ———
 ————                              62
 3360                              20
 560                              ————
 ————                            1248 p. w.
1248) 8960 (7 Vessels of each
      8736
     ——————
Rem. (224)    p. w.
```

The Proof of the Work is as followeth, viz.

				l. oz. p.w.
7	*Bowls of* 2—08—00	per *Bowl*	is	18—08—00
	Tank. of 1—06—00	per *Tank.*	is	10—06—00
	Salts of 0—10—10	per *Salt*	is	06—01—10
	Spoons of 0—01—18	per *Spoon*	is	01—01—06
	224 *Penny-weight remaining*		is	00—11—04
		Total Sum		37—04—00

So that you see the Sum of the Weights of each Vessel, together with the Remainder is 37l. 4 oz. which is equal to the Weight of the 16 Ingots delivered. For if 37l. 4 oz. be reduced to Penny-weights it makes 8960.

Reduction of Averdupois Weight.

In reducing *Averdupois-Weight*, the Learner must have Recourse to the Table of *Averdupois-Weight*, delivered in the 2d Chapter foregoing.

Quest. 16. In 47 C. 1 qr. 20l. how many Ounces? Multiply by 4. by 28, and by 16, and the last Product will be the Answer, viz. 84992 Ounces.

```
C.      qr.      l.
47———————1———————20
 4
———
189 Quarters
 28
———
1512
380
———
5312 Pounds
  16
—————
31872
5312
—————
Facit 84992 Ounces.
```

Quest.

Quest. 17. In 84992 Ounces, I demand how many C. qrs. l.

This is the foregoing Queſtion inverted, and will be reſolved if you divide by 16, by 28, and by 4, and the Anſwer is 47 C. 1 qr. 20l. equal to the given Numbers in the foregoing Queſtion.

```
           28     4]   C.   qr.   lb.
16]84992[5312[189[47———1———20
   ....   ...   ..
   80     28    16
  ————   ————  ————
    49    251    29
    48    224    28
  ————   ————  ————
    19    272   (1) qr.
    16    252
  ————   ————
    32   (20)
    32
  ————
   (0)
```

Queſt. 18. A Chapman buyeth of a Grocer 4 C. 1 qr. 14l. of Pepper and ordered it to be made up into Parcels of 14l, of 12l, of 8l, of 6l. and of 2l. and of each Parcel an equal Number now I would know the Number of each Parcel.

This Example is of the ſame Nature with the 11th, and 12th, and 15 Queſtions foregoing, and after the ſame manner is reſolved. See the Operation as followeth.

C.	qr.	l.	l.
4	1	14	14
4			12
			8
17			6
28			2
140			42 *Pounds*
35			

42) 490 (11
42
70 *Facit* 11 *Parcel of each*
42
Rem. (28) *Pounds*

Reduction of Liquid Measure.

Quest. 19. In 45 Tun of Wine, how many Gallons? Multiply by 4, and by 63, the Product is 11340 Gallons, for the Answer.

45
4
180
63
540
1080
Facit 11340 *Gallons*

Quest. 20. In 43 Runlets of Wine, each containing 18 Gallons, I demand how many Hogsheads?

First

First, Find how many Gallons are in the 34 Runlets which you may do if you multiply 34 by 18, the Content of a Runlet, and the Product is 612 Gallons, which you may reduce into Hogsheads if you divide them by 63, and the Quote will be 9 Hogsheads, and 45 Gallons. See the Work.

34
18

272
34

63) 612 (9 Hogsheads.

567

Rem (45) Gallons
Facit 9 Hogsheads 45 Gallons.

Quest. 21. In 12 Tuns how many Runlets of 14 Gallons *per.* Runlet?

Reduce your Tuns into Gallons, and divide them by 14, the Gallons in a Runlet, and the Quotient (216) is your Answer.

12
4

48
63

144
288

3024

14)

14) 3024(216

28

22
14

84
84

(0)

Facit 216 *Rundlets.*

Reduction of Long-Measure.

Quest. 22. I demand how many Furlongs, Poles, Inches and Barly-Corns will reach from *London* to *York*, it being accounted 151 Miles?

	151	*Miles.*
	8	*Furlongs in a Mile.*
	1208	*Furlongs*
	40	*Poles in a Furlong.*
	48320	*Poles*
	11	*Half-Yards*
	48320	
	48320	
	531520	*Half-Yards*
	18	*Inches in Half a Yard.*
	4252160	
	531520	
	9567360	*Inches*
	3	*Barly-Corns in an Inch*
Facit	28702080	*Barly Corns in a 151 Miles*

Quest.

Quest. 23. The Circumference of the Earth, as all other Circles are, is divided into 360 Degrees and each Degree into 60 Minutes, which, upon the Superficies of the Earth are equal to 60 Miles; now I demand how many Miles, Furlongs, Perches, Yards, Feet, Barly-Corns will reach round the Globe of the Earth?

360	*Degrees.*
60	*Minutes or Miles in a Degree*
21600	*Miles about the Earth*
8	*Furlongs in a Mile*
172800	*Furlongs about the Earth*
40	*Perches in a Furlong*
6912000	*Poles or Perches about the Earth*
11	*Half-Yards in a Perch*
6912000	
6912000	
2)76032000	*Half-Yards about the Earth*
[38016000	*Yards, viz. the Half-Yards*
3	*divided by 2*
114048000	*Feet about the Earth*
12	*Inches in a Foot*
228096000	
114048000	
1368576000	*Inches about the Earth*
3	*Barly-Corns in an Inch*
Facit. 4105728000	*Barly-Corns about the Earth*

And

And so many will reach round the World, the whole being 21600 Miles; so that if any Person were to go round, and go 15 Miles every Day, he would go the whole Circumference in 1440 Days, which is 3 Years 11 Months, and 15 Days.

Reduction of Time.

Quest. 24. In 28 Years, 24 Weeks, 4 Days, 16 Hours, 30 Minutes, how many Minutes?

Years *Weeks* *Days* *Hours* *Min.*
28——24——4——16——30
52 *Weeks in a Year.*

60
142

1480 *Weeks*
7

10364 *Days*
24

41462
20729

248752 *Hours*
60

14925150 *Minutes*

Note, That in resolving the last Question after the Method expressed, there is lost in every Year 30 Hours, for the Year consisteth of 365 Days and 6 Hours, but by multiplying the Years by 52 Weeks, which is but 364 Days; you lose 1 Day and 6 Hours every Year, wherefore to find an exact Answer bring the odd Weeks, Days, and Hours into Hours, and then multiply the Years by the Number of Hours in a Year, *viz.* 8766, and to the Product add the Hours con-

contained in the odd time, and you have the exact Time in Hours, which bring into Minutes as before. See the last Question thus resolved.

Weeks, Days, Hours,
24 —— 4 —— 16
7
————
172
24
————
694
345
————
4144 *hours*

days *hours*
365 —— 6
24
————
1466
730
————
8766 *hours in a year*

28
8766
————
172
172
197
228
————
249592 *hours*
60
————
1497552o *minutes in* 28 *years and* 4144 *hours.*

So you see that according to the Method first used to resolve this Question, the Hours contained in the given Time are 248752, but according to the last, best, or true Method, they are 249592, which exceeds the former by 840 Hours.

But for most Occasions it will be sufficient to multiply the given Years by 365, and to the Product add the Days in the odd Time, if there be any, and then there will be only a Loss of 6 Hours in every Year, which may be supplied by taking a fourth part of the given Years, and adding it to the contained Days, and you have your desire.

Quest. 25. In 428657540 Minutes, how many Years? *Facit* 834 *Years,* 3 *Days,* 19 *Hours.*

8766) Years Days Hours
6|0)438657540 (7310959 (834—4—19

42	70128
18	29815
18	26298
6	35179
6	35064
57	24) 115 (4 *days*
54	96
35	(19) *hours*
30	
54	
54	
(0)	

Quest. 26. I desire to know how many Hours and Minutes it is since the Birth of our Saviour Jesus Christ, to this present Year being accounted 1700 Years?

This Question is of the same Nature with the 24th foregoing, and after the same manner is resolved, *viz.* Multiply the given Number of Years by 8766, the Product is 14902200 Hours, and that by 60, and the Product is 894132000 Minutes. See the Work.

1700 *years*
8766 *hours in a year*

10200
10200
11900
13600

149022000 *hours in* 1700 *years*
60

8941320000 *min. in* 1700 *years*

Note

Note that as Multiplication and Division do interchangeably prove each other, so Reduction descending and ascending prove each other, by inverting the Question, as the 13th and 14th and likewise the 16th and 17th Questions foregoing by Inversion do interchangeably prove each other, the like may be performed for the Proof of any Question in Reduction whatsoever.

Thus far have we discoursed concerning single Arithmetick, whose Nature and Parts are defined in the 2d. 8th, 9th, and 10th Definitions of the 3d Chapter of this Book, for although Reduction is not reckoned or defined among the parts of single Arithmetick, yet considered abstractly it is the proper Effect of Multiplication and Division; and as for the Extraction of Roots, which ought to be handled in the next Place as Parts of single Arithmetick, we shall omit it in this Place, and refer the Learner to Mr. *Cocker's* Decimal Arithmetick, which is, with great Care and Pains, now published, together with his Logarithmetical Arithmetick shewing the Genesis or Fabric of the Logarithms, and their general Uses in Arithmetick, &c. As also his Algebraical Arithmetick, containing the Doctrine of composing and resolving an Equation, with all other Rules necessary for the understanding that Mysterious Art, &c.

CHAP. IX.

Of Comparative Arithmetick; viz. *The Relation of Numbers One to another.*

1. Comparative Arithmetick, is that which is wrought by Numbers, as they are considered to have Relation one to another, and this consists in Quantity, or in Quality. *Lucius Arith. lib. 2. cap. 1.*

K

2. Re-

2. Relation of Numbers in Quantity is the Reference or Respect, that the Numbers themselves have one to another, where the Terms or Numbers propounded are always two the first called the Antecedent, and the other the Consequent.

Vide Wing. 4 lib. chap. 34.

3. The Relation of Numbers in Quantity consists in the Differences, or in the Rate or Reason that is found betwixt the Terms propounded, the Difference of two Numbers being the Remainder found by Subtraction, but the Rate or Reason betwixt 2 Numbers is the Quotient of the Antecedent divided by the Consequent. So 21 and 7 being given the Difference betwixt them will be found to be 14, but the Rate or Reason that is betwixt 21 and 7 will be found to be triple Reason, for 21 divided by 7 Quotes 3, the Reason or Rate.

Alsted. Mathemat. lib. 2. cap. 11. and 14.

4. The Relation of Numbers in Quality, otherwise called Proportion, is the Reference or Respect that the Reason of Numbers have one to another; therefore the Terms given ought to be more than two. Now this Proportion or Reason between Numbers relating one to another, is either Arithmetical, or Geometrical.

Alsted. Mathe. lib. 2. cap. 21.

5. Arithmetical Proportion, by some called Progression, is when divers Numbers differ one from another by equal Reason, that is have equal Differences.

So this Rank of Numbers 3, 5, 7, 9, 11, 13, 15, 17, differ by equal Reason; *viz.* by 2, as you may prove.

6. In a Rank of Numbers that differ by Arithmetical Proportion, the Sum of the first and last Terms being multiplied by half the Number of Terms, the Product is the Total Sum of all the Terms.

Or if you multiply the Number of the Terms by the half Sum of the first and last Terms, the Product thereof will be the Total Sum of all the Terms.

So

So in the former Progression given, 3 and 17 is 20 which multiplied by 4 (*viz.* half the Number of Terms) the Product gives 80 the Sum of all the Terms; or Multiply 8 (the Number of Terms) by 10 (half the Sum of the first and last Terms) the Product gives 80 as before.

So also 21, 18, 15, 12, 9, 6, 3, being given, the Sum of all the Terms will be found to be 84; for here the Number of Terms is 7, and the Sum of the first and last (*viz.* 21 and 3) is 24, half whereof, (*viz.* 12) multiplied by 7 produceth 84, the Sum of the Terms sought.

7. Three Numbers that differ by Arithmetical Proportion, the Double of the mean, or middle Number, is equal to the Sum of the Extremes.

So 9, 12, and 15, being given the Double of the mean 12, *viz.* 24, is equal to the Sum of the Extremes 9 and 15.

8. Four Numbers that differ by Arithmetical Proportion, either continued or interrupted, the Sum of the two Means is equal to the Sum of the two Extremes.

So 9, 12, 18, 21, being given, the Sum of 12 and 18 will be equal to the Sum of 9 and 21, *viz.* 30; also 6, 8, 14, 16, being given, the Sum of 8 and 14 is equal to the Sum of 6, and 16. *viz.* 22, &c.

Vide Wing. Arith chap. 35.

9. Geometrical Proportion, by some called Geometrical Progression is when divers Numbers differ according to like Reason.

So 1, 2, 4, 8, 16, 32, 64, &c. differ by double Reason, and 3, 9, 27, 81, 243, 729, differ by triple Reason, 4, 16, 64, 256, &c. differ by quadruple Reason, &c.

10. In any Numbers that increase by Geometrical Proportion, multiply the last Term by the Quotient of any one of the Terms divided by another of the Terms which being less is next unto it and having deducted or subtracted the 1st Term out of that Product, divide the Remainder by a Number that is all a Unit

less

less than the said Quotient, the last Quote will give the Sum of all the Terms.

So, 1, 2, 4, 8, 16, 32, 64, being given, first I take one of the Terms, *viz.* 8, and divide it by the Term which is less and next to it, *viz.* by 4, and the Quotient is 2, by which I multiply the last Term 64, and the Product is 128 from whence I subtract the first Term, (*viz.*) 1 the remainder is 127, which divided by the Quotient 2 made less by 1, *viz.* 1, the Quote is 127, for the Sum of all the given Terms, as by the Work in the Margin.

```
     64
 4) 8 (2
 -------
    128
      1
 -------
 1)127(127
```

So if 4, 16, 64, 256. 1024, were given, the Sum of all the Terms will be found to be 1364. For first, I divide 64 one of the Terms by his next lesser Term, and the Quotient is 4, by which I multiply the last Term 1024, and it produceth 4096 ? from whence I subtract the first Term 4, and the Remainder is 4092, which I divide by the Quote less 1, *viz.* 3, and the Quote is 1364, for the total Sum of all the Terms, as *per* Margin.

```
      1024
  16)64(4
  ---------
      4096
         4
  ---------
  3)4092(1364
```

So likewise if 2, 6, 18, 54, 162, 486, were given, the Sum or Total of all the Terms will be found to be 728. See the Work.

```
      486
  6) 18 (3
  ---------
     1458
        2
  ---------
  2) 1456 (728
```

11. Three Geometrical Proportionals given the Square of the Mean is equal to the Rectangle, or Product of the Extremes.

So 8, 16, 32, being given, the Square of the Mean, *viz.* 16 is 256, which is equal to the Product of the Extremes 8 and 32, for 8 times 32 is equal to 256.

12. Of 4 Geometrical Proportional Numbers given, the Product of the two Means is equal to the Product of the two Extremes.

So

So 8, 16, 32, 64, being given, I say that the Product of the two Means, viz. 16 times 32, which is 512, is equal to 8 times 64 the Product of the Extremes.

Also if 3, 9, 21, 63, were given, which are interrupted, I say 9 times 21 is equal to 3 times 63, which is equal to 189.

From hence ariseth that precious Gem in Arithmetick, which for the Excellency thereof is called the *Golden Rule, or Rule of Three.*

CHAP. X.

The Single Rule of Three Direct.

1. THE *Rule of Three*, not undeservedly called the *Golden Rule*, is, that by which we find out a 4th *Number* in *Proportion* unto *Three* given *Numbers*, so as this *fourth Number* sought may bear the same Rate, Reason, or Proportion to the *third* given *Number*, as this 2d doth to the 1st, from whence it is also called the Rule of *Proportion.*

2. Four *Numbers* are said to be *Proportional*, when the 1st containeth or is contained by the 2d, as often as the 3d containeth or is contained by the 4th, *Vide* Wingate's *Arith. chap.* 8. *Sect.* 4.

So these *Numbers* are said to be *Proportionals*; *viz.* 3, 6; 9, 18, for as often as the 1st *Number* is contained in the 2d, so often is the 3d contained in the 4th, *viz.* twice. Also 9, 3, 15, 5, are said to be *Proportional* for as often as the 1st *Number* containeth the 2d, so often the 3d *Number* containeth the 4th, *viz.* 3 times.

3. The Rule of Three is either simple or composed.

4. The simple, single Rule of *Three*, consisteth of 4 *Numbers*, that is to say, it hath 3 *Numbers* given to find out a fourth; and this is either Direct, or Inverse. *Vide Alsted. Math. lib.* 2. *cap.* 13.

5. The single Rule of Three Direct, is when the Proportion of the first Term is to the second, as the third is to the fourth; or when it is required that the Number sought *viz.* the fourth Number must have the same Proportion to the second, as the third hath to the first.

6. In the Rule of Three, the greatest Difficulty is, after the Question is propounded, to discover the Order of the 3 Terms, *viz.* which is the first, which is the second, and which the third, which that you may understand, observe, That, of the three given Numbers, two are always of one Kind, and the other is of the same Kind with the proportional Number that is sought as in this Question, *viz.* If 4 Yards of Cloth cost 12 Shillings, what will 6 Yards cost at that Rate? Here the two Numbers of one kind are 4 and 6, *viz.* they both signifie so many Yards; and 12 Shillings is the same Kind with the Number sought, for the Price of 6 Yards is sought.

Again, observe, that of the 3 given Numbers, those two that are of the same Kind, one of them must be the first and the other the third, and that which is of the same Kind with the Number sought; must be the 2d Number in the Rule of Three; and that you may know which of the said Numbers to make your first, and which your third, know this, that to one of those two Numbers there is always affixed a Demand and that Number upon which the Demand lieth must always be reckoned the third Number. As in the forementioned Question, the Demand is affixed to the Number 6 for it is demanded what 6 Yards will cost? and therefore 6 must be third Number, and 4, which is of the same Denomination, or Kind with it, must be the first, and consequently the Number 12 must be the second, and then the Numbers being placed in the forementioned Order, will stand as followeth *viz.*

Yards	s.	Yards
4.	12.	6.

7. In the Rule of Three Direct, having placed the *Numbers* as is before directed, the next Thing to be done will be to find out the 4th *Number* in proportion which, that you may do, multiply the 2d *Number* by the 3d, and divide the Product thereof by the 1st, or which is all one, Multiply the 3d Term, or Number by the 2d, and divide the Product thereof by the 1st, and the Quotient thence arising is the 4th *Number* in a direct Proportion, and is the *Number* sought, or Answer to the Question, and is of the same Denomination that the 2d Number is of. As thus, let the same Question be again repeated, *viz.* If 4 Yards of Cloth cost 12 Shillings, what will 6 Yards cost?

Having placed my Numbers according to the 6th Rule of this Chapter foregoing, I multiply the 2d Number 12 by the 3d Number 6, and the Product is 72, which Product I divide by the 1st Number 4, and the Quotient thence arising is 18, which is the 4th Proportional, or Number sought *viz.* 18 Shillings because the 2d Number is Shillings which is the Price of the 6 Yards, as was required by the Question. See the Work following.

	yds.		s.		yds.		s.
If	4	——	12	——	6	——	18

```
         12
          6
       ------
    4) 72 (18 shill.
          4
       ------
         32
         32
       ------
         (0)
```

Quest. 2. Another Question may be this, *viz.* If 7 *C.* of *Pepper* cost 21 *l.* how much will 16 *C.* cost at that Rate?

To resolve which Question, I consider that (according to the 6th Rule of this Chapter) the Terms or Numbers ought to be placed thus *viz.* the Demand lying upon

upon 16C. it must be the 3d Number & that of the same Kind with it must be the 1st, viz. 7C. and 21l. (being of the same Kind with the Number sought) must be 2d Number in this Question; then I proceed according to this 7th Rule, and multiply the 2d Number or the 3d, viz. 21 by 16, and the Product is 336, which I divide by the first Number 7, and the Quotient is 48l. which is the Value of 16C. of Pepper at the Rate of 21l. for 7C. See the Work following.

```
     C.         l.        C.
If 7 ———————— 21 ———————— 16.
               16
             ————
              126
              21
             ————
         7) 336 (48l.
              28
             ————
              56
              56   Fac. 48l.
             ————
              (0)
```

8. If when you have divided the Product of the 2d and 3d Numbers by the 1st, any Thing remain after Division is ended, such Remainder may be multiplied by the Parts of the next inferior Denomination, that are equal to an Unit (or Integer) of the 2d Number in the Question, and the Quotient is of the same Denomination with the Parts by which you multiplied the Remainder, and its Part of the 4th Number which is sought. And furthermore, if any Thing remain, after this last Division is ended, multiply it by the Parts of the next inferior Denomination equal to an Unit of the last Quotient, and divide the Product by the same Divisor (viz. the first Num-

ber

ber in the Question) and the Quote is still of the same Denomination with your Multiplier; follow this Method until you have reduced your Remainder into the lowest Denomination, *&c.* An Example or two will make the Rule very plain, which may be this following.

Quest. 3. If 13 Yards of Velvet (or any other Thing) cost 21l. what will 27 Yards of the same cost at that Rate?

Having ordered and wrought my Numbers according to the 6th and 7th Rules of this Chapter, I find the Quotient to be 43l. and there is a Remainder of 8, so that I conclude the Price of 27 Yards to be more than 43l and to the Intent that I may know how much more, I work according to the foregoing Rule, *viz.* I multiply the said Remainder 8 by 20s. (because the 2d Number in the Question was Pounds) and the Product is 160, which divided by the 1st Number, *viz.* 13, it quotes 12, which are 12 Shillings, and there is yet a Remainder of 4, which I multiply by 12 Pence, because the last Quotient was Shillings, and the Product is 48, which I divide by 13, the 1st Number; and the Quotient is 3d. and yet there remaineth 9, which I multiply by 4 Farthings, and the Product is 36, which divided by 13 again, it quotes 2 Farthings, and there is yet a Remainder of 10, which, because it cometh not to the Value of a Farthing, may be neglected or rather set after the two Farthings over the Divisor, with a Line between them, and then (by the 21 and 22 Definitions of the first Chapter of this Book) it will be $\frac{10}{13}$ of a Farthing; so that I conclude, that if 13 Yards of Velvet cost 21l; 27 Yards of the same will cost 43l, 12s, 3d, $2\frac{10}{13}$ qrs. which Fraction is 10 Thirteenths of a Farthing. See the Operation as followeth.

```
      yds.       l.        yds.
If. 13 ———— 21 ———— 27
             27
           ————
            147
            42
          ——————
  13) 567 (43l.
      . .
      52
     ————
      47
      39
     ————
Rem.  (8)
Multiply 20
    ————
  13) 160(12s.
      . .
      13
     ————
      30
      26
     ————
Rem.  (4)
Multiply 12
     ————
  13) 48 (3d.
      39
     ————
Rem. (9)
Multiply 4
     ————
  13) 36 (2 10/13 qrs.
      26
     ————                      l.   s.   d.   qrs.
Remains (10)       Facit 43—12—3—2 10/13
```

Quest. 4. Another Example may be this following. If 14l. of Tobacco cost 27s. what will 478l. cost at that Rate?

Work

Work according to the last Rule, and you will find it to amount to 921s. 10d. $1\frac{2}{14}$ qrs, and by the 5th Rule of the 8th Chapter 921s may be reduced to 46l. 1s. So that then the whole Worth or Value of the 478 l. will be 46l. 1s. 10d. $1\frac{2}{14}$ qrs. the whole Work followeth.

```
      l.      s.      l.
  If  14——————27——————478
                       27
              ———————————
                     3346
                     956
              ———————————
                    12906(92|1 (46l.
                     126    8
                    —————  ———
                      30   12
                      28   12
                    ————— —————
                      26
                      14
                    —————
               Rem. (12)
          Multiply   12
                   ———————
                      24
                      12
                   ———————
                  14) 144 (10d.
                       14
                   ———————
               Rem.   (4)
          Multiply     4
                   ———————
                  14)  16 (1 2/14 qr.
                       14
                   ———————
               Rem.   (2)
          l.   s.   d.   qr.
    Facit 46———1———10———1 2/14
```

In

§. 9. In the Rule of Three it many Times happeneth, that although the 1st and 3d Numbers be Homogeneal (that is, one Kind) as both Money, Weight, Measure, &c. yet they may not be of one Denomination, or perhaps they may both consist of many Denominations; in which case you are to reduce both Numbers to one Denomination; and likewise your 2d Number, if it consisteth, at any time, of divers Denominations, must be reduced to the least Name mentioned, or lower if you please, which being done, multiply the 2d and 3d together, and divide by the 1st, as is directed in the 7th Rule of this Chapter.

And note that always the Answer to the Question is in the same Denomination that your 2d Number is of, or is reduced to, as was hinted before.

Quest. 5. If 15 Ounces of Silver be worth 3l. 15s. what are 86 Ounces worth at that Rate?

In this Question the Numbers being ordered according to the 6th Rule of this Chapter, the 1st and 3d Numbers are Ounces, and the 2d Number is of divers Denominations, *viz.* 3l. 15s. which must be reduced to Shillings, and the Shillings multiplied by the 3d Number, and the Product divided by the 1st gives you the Answer in Shillings, *viz.* 430 Shillings, which are reduced to 21l. 10s. See the Work.

```
     oz.      l.     s.      oz.
  If 15 ———— 3 ——— 15 ———— 86
            20
           ————
            75
            86
           ————
           450
          600
     ——————————————  2|0   l.   s.
     15) 6450 (      43|0(21—.10
         60          4
        ————        ————
         45          3
         45          2
        ————        ————
         (0)        (10
```

In resolving the last Question, the Work would have been the same, if you had reduc'd your second Number into Pence, for then the Answer would have been 5160 Pence, equal to 21 l. 10s. or if you had reduced the second Number into Farthings, the Quotient or Answer would have been 20640 Farthings equal to the same, as you may prove at your Leisure.

Quest. 6. If 8l. of Pepper cost 4s. 8d. what will 7 C. 3 qrs. 14*l.* cost?

In this Question the first Number is 8 l. and the third is 7 C. 3 qrs. 14l. which must be reduced to the same Denomination with the first *viz.* into Pounds, and the second Number must be reduced into Pence; then multiply and divide according to the 7th Rule foregoing, and you will find the Answer to be 6174 Pence, which is reduced into 25l. 14s. 6d.

```
      l.   s. d.           C. qrs. l.
If 8 cost 4—8 what will 7—3—14 cost?
          12                4
          ——               ——
          56               31
                           28
                          ———
                          252
                          63
                          ———
                          882
                           56 Second Number.
                         ————
                         5292
                         4410
                        —————      12)      2|0)  l.  s.  d.
                      8) 49392   (6174    (51|4(25—14—6
                         ....     ...       ..
                         48        60        4
                         ——        ——        ——
                          13       17        11
                           8       12        10
                         ——        ——        ——
                          59        54      (14)s.
                          56        48
                          ——        ——
                           32      (6)d.
                           32              l.  s.  d.
                          ——
                          (0)   Facit 25: 14. 6
```

Quest. 7. If 3 C. 1 qr. 14 l. of Raisins cost 9 l. 9 s. what will 6 C. 3 qrs. 20 l. of the same Cost?

Here the first and third Numbers each consist of divers Denominations, but must be brought both into one Denomination, *&c.* as you see in the Operation which followeth; the Answer is 388 s. which is reduced into 19 l. 8 s.

```
    C.  qr.  lb.      l. s.           C.  qr.  lb.
If  3 — 1 — 14 cost   9—9  what will  6 — 3 — 20 cost?
    4                  20             4
  ----                ----          ----
   13                 189 Shill.     27
   28                                28
  ----                             ----
  108                               216
   27                                56
  ----                             -----
  378 Pounds                        776 Pounds
                                    189 Second Number
                                   -----
                                   6984
                                  6208
                                  776
                                  ------  2|0)  l.  s.
                             378)146664 (38|8 (19—8
                                  1134     2
                                  ----    --
                                   3326   18
                                   3024   18
                                   ----   --
                                    3024 (8)
                                    3024
                                    ----
                                    (0) s.
```

Quest. 8. If in 4 Weeks I spend 13 s. 4 d. how long will 53 l. 6 s. last me at that Rate?

Answer, 2238 Days equal to 6 Years, 48 Days. See the Work.

If

```
   s. d.          w.          l.   s.
If 13—4 require  4 what will 53—06
   12             7           20
   ——            ——          ——
   30           28 Days     1066
   13                         12
   ——                        ——
  160 Pence                 2132
                            1066
                           ——
                           12792 Pence
                              28 Second Number
                           ——
                           102336
                           25584
                           ——— 365)
                   16|0) 35817|6(2238(6 Years
                          ....      2190
                          32        ——
                          ——Rem. (48) Days
                          38
                          22
                          ——          Yrs.  Days
                           61 Facit    6 — 48
                           48
                           ——
                           137
                           128
                           ——
                            (96) Remains
```

Quest. 9. Suppose the yearly Rent of a House, a yearly Pension, or Wages be 73 l. I desire to know how much it is *per* Day?

Here you are to bring the Year into Days, and say, if 365 Days require 73 l. what will one Day require?

Now when you come to multiply 73 by 1, the Product is the same, for one neither multiplieth nor divideth, and 73 cannot be divided by 365. because the Divisor is bigger than the Dividend, wherefore bring the

the 73l. into Shillings and they make 1460, which divide by the first Number 365, and the Quote is 4 Shillings for the Answer, as you see in the Work.

Days l. Day,
If 365——73——1
20

365) 1460 (4s.
1460 Facit 4s. per Day

(o)

Quest. 10. A Merchant bought 14 Pieces of Broad-Cloth, each Piece containing 28 Yards, for which he gave after the Rate of 13s. 6d. ½ *per* Yard, now I desire to know how much he gave for the 14 Pieces at that Rate?

First, Find out how many Yards are in the 14 Pieces, which you will do if you multiply the 14 Pieces by 28 (the Number of Yards in a Piece) and it makes 392; then say, If 1 Yard cost 13s. 6½d. what will 392 Yards cost? Work as followeth; and the Answer you will find to be 127400 Half-pence, which reduced make 265l. 8s. 4d. For after you have multiplied your second and third Numbers together, the Product is 127400, which, according to the seventh Rule, should be divided by the first Number, but the first Number is 1, which neither multiplieth nor divideth, and therefore the Quotient or fourth Number is the same with the Product of the Second and Third, which is in Half-pence, because the second Number was so reduced. See the Work as followeth.

```
                28
                14
               ----
               112
                28
               ----
               392
                   Yards in the 14 Pieces.

Yd.      s.  d.                  Yds.
If 1 cost 13—6 ½ what will  392 cost?
          12                325 the second Number.
        -----             ------
          32                1960
         13                 784
        -----              1176
         162              ------       2|0     l.    s.  d.
           2           24) 127400 (530|8 (265 — 8 — 4
        -----              ....:   ..:
Half-pence 325             120     4
                          -----   ---
                             74    13
                             72    12
                            ----  ----
                            200    10
                            192    10
                            ----  ----
                                   (8) Shillings
Facit 265 l. 8s. 4d.          Rem. (8) ½ Pence, or 4d.
```

Quest. 11. A Draper bought 420 Yards of Broad-Cloth, and gave for it after the Rate of 14s. 10d. ¾ *per.* Ell *English*, now I demand how much he paid for the whole at that Rate?

Bring your Ell into Quarters, and your given Yards into Quarters, the Ell is 5 Quarters, and in 420 Yards are 1680 Quarters; then say, If 5 Quarters cost 14s. 10¾ d. (or 715 Farthings) what will 1680 Quarters cost? *Facit.* 250 l. 5s. 0d. See the Operation.

```
     Ell.              Yards.
      1                 420
      5                   4
    ------           ---------
     5 qrs.           1680 qrs.
If 5 —— 14 — 10¾ ———————— 1680
       12                  715
     ------           ---------
       28                 8400
     15                   1680
    -------            11760
     178d             ---------- 96|0]
       4             5] 1201200 [24024|0 [250l.
    -------
     715 qr.            10        192
                     -------   ---------
                        20        482
                        20        480
                     -------   ---------
                        12     48] 240 [5 s.
                        10         240
                     -------    --------
                        20          [0]
     l.     s.          20
Facit 250 —— 5       -------
                        [0]
```

Quest. 12. A Draper bought of a Merchant 50 Pieces of Kersey, each Piece containing 34 Ells *Flemish*, (the Ell *Flemish* being 3 Quarters of a Yard) to pay after the Rate of 8s. 4d. per Ell *English*, I demand how much the 50 Pieces cost him at that Rate?

First. Find how many Ells *Flemish* are in the 50 Pieces by multiplying 50 by 34, the Product is 1700, which bring into Quarters by 3, it makes 5100 Quarters, then proceed, as in the last Question, and the Answer you will find to be 102000 Pence, or 425l. Behold the Operation, as followeth.

If,

s. d.
8——4
12

100 d.

34
50

1700 Ell Flemish.
3

5100 qrs.

qrs. d. qrs.
If 5——100——5100
100

2410]d.
5] 510000 [102000 [425 l.

5 96

10 60
10 48

[000] 120
120

Facit 425 l.

[00]

Quest. 13. A Goldsmith bought a Wedge of Gold, which weighed 14 l. 3 oz. 8 p. w. for the Sum of 514 l. 4s. I demand what it stood him in per Ounce [Answer, 60 Shillings, or 3 l. See the Work.

l. oz. p. w. l. s. oz.
If 14——3——8——514——4——1
12 20 Shillings 20

31 10284 Shillings 20 p. w.
14 20 p. w.

171 oz. 3428] 205680 [60 [3 l.
20 6

3428 p. w. 20568 s. l.
[0] Facit 60 or 3
[0]

Quest.

Quest. 14. A Grocer bought 4 *hhds.* of Sugar, each weighing neat 6*C.* 2 *qrs.* 14l. which cost him 2l. 8s. 6d. per *C.* I demand the Value of the 4 *hhds.* at that Rate? First, Find the Weight of the 4 *hhds.* which you may do by reducing the Weight of one of them into Pounds, and multiply them by 4 (the Number of *hhds.*) and they make 2968l. then say, If 1*C.* or 112l. cost 2l. 8s. 6d. what will 2968l. cost? *Facit* 64l. 5s. 3d. As by the Operation.

C. — qrs. — l.
6 — 2 — 14
4

26
28

212
53

742 l. in 1 *hhd.*
4 *hhds.*

2968 l. in 4 *hhds.*

l. — l. — s. — d. — l.
If 112 — 2 — 8 — 6 — 2968
20 — 582

48 — 5936
12 — 23744
— 14840

582 — 112) 1727376 (15423 (1285 (64l.
— 12) — 2|0)

112 — 12 — 12

607 — 34 — 8
560 — 24 — 8

473 — 102 — (5) *Shillings*
448 — 96

257 — 63
224 — 60

336 — (3) *Pence*
336

(0)

l. — s. — d.
Facit 64 — 5 — 3

Quest.

Quest. 15. A Draper bought of a Merchant 8 Packs of Cloth, each Pack containing 4 Parcels, and each Parcel 10 Pieces, and in each Piece 26 Yards, and gave after the Rate of 4l. 16s. for 6 Yards; now I desire to know how much he gave for the whole? *Answer.* 6656l.

First, Find out how many Yards there were in the 8 Packs, by the following Work you will find there are 8320 Yards; then say, If 6 Yards cost 4l. 16s. what will 8320 Yards cost, &c.

8 *Packs.*
4
―――
32 *Parcels.*
10
―――
320 *Pieces.*
26
―――
1920
640
―――
8320 *yds.*

yds. l. s. yds.
If 6 —— 4 —— 16 —— 8320
20 96
――― ―――
96 49920
74880
――― 2|0
6]798720[13312|0 [6656l.

6 12
――― ―――
19 13
18 12
――― ―――
18 11
18 10
――― ―――
7 12
6 12
――― ―――
12 (0)
12
―――
Facit 6656l. (0)

By this Time the Learner is, I suppose, well exercised in the Practic and Theoric of the Rule of Three Direct, but at his Leisure he may look over the following Questions, whose Answers are given, but the Operation purposely omitted as a Touchstone for the Learner, thereby to try his Ability in what hath been delivered in the former Rules.

Quest. 16. If 24l. of Raisins cost 6s. 6d. what will 18 Frails cost, each weighing neat 3 qrs. 18l. *Answer*, 24l. 17s. 3d.

Quest. 17. If an Ounce of Silver be worth 5s. what is the Price of 14 Ingots each weighing 7l. 5 oz. 10 p. w. *Answer*, 313l. 5s.

Quest. 18. If a Piece of Cloth cost 10l. 16s. 8d. I demand how many Ells *English* there are in the same, when the Ell at that Rate is worth 8s. 4d? *Answer*, 26 Ells *English*.

Quest. 19. A Factor bought 84 Pieces of Stuffs, which cost him in all 537l. 12s. at 5s. 4d. per Yard. I demand how many Yards there were in all, and how many Ells *English* were contained in a Piece of the same? *Answer*, 2016 Yards in all, and $19\frac{1}{5}$ Ells *English* per Piece.

Quest. 20. A Draper bought 242 Yards of Broad-Cloth which cost him in all 254l. 10s. for 86 Yards of which he gave after the Rate of 21s. 4d. per Yard. I demand how much he gave per Yard for the Remainder? *Answer*, 20s. 10d. $\frac{64}{156}$ per Yard.

Quest. 21. A Factor bought a certain Quantity of Serge and Shalloon, which together cost him 226l 14s. 8d. the Quantity of Serge he bought was 48 Yards at 3s. 4d. per Yard, and for every two Yards of Serge he had 5 Yards of Shalloon, I demand how many Yards of Shalloon he had, and how much the Shalloon cost him per Yard? *Answer*, 120 Yards of Shalloon at 1l. 16s. $5\frac{48}{120}$d. per Yard.

Quest. 22. An Oyl-Man bought 3 Tuns of Oyl, which cost him 151l. 14s. and it so chanced that it leaked out 82 Gallons, but he is minded to sell it again, so as that he may be no Loser by it; I demand how he must sell it per Gallon? *Answer*, at 4s. $6\frac{12}{674}$d. per Gallon.

Quest. 23. Bought 6 Packs of Cloth, each Pack containing 12 Cloths, which at 8s. 4d. per Ell *Flemish* cost 1080l. I demand how many Yards there were in each Cloth? *Answer*, 27 Yards in each Cloth.

Quest. 24. A Gentleman hath 536l. per Annum, and his Expences are one Day with another 18s. 10d. 3 qrs. I desire to know how much he layeth up at the Year's End? *Answer*, 191l. 3s. 0d. 1 qr.

Quest. 25. A Gentleman expendeth daily one Day with another 27s. $10\frac{1}{2}$d. and at the Year's End layeth up 340l. I demand how much is his Yearly Income? *Answer*. 848l. 14s. $4\frac{1}{2}$d.

Quest. 26. If I sell 14 Yards for 10l. 10s. 0d. how many Ells *Flemish* shall I sell for 283l. 17s. 6d. at that Rate? *Answer*, $504\frac{4}{5}$ Ells *Flemish*.

Quest. 27. If 100l. in 12 Months gain 6l. Interest, how much will 75l. gain in the same Time, and at the same Rate? *Answer*, 4l. 10s.

Quest. 28. If 100l. in 12 Months gain 6l. Interest, how much will it gain in 7 Months at that Rate? *Answer*, 3l. 10s.

Quest. 29. A certain Usurer put out 75l. for 12 Months, and received Principal and Interest 81l. I demand what Rate per Cent, he received Interest? *Answer*, 8l. per Cent.

Quest. 30. A Grocer bought 2 Chests of Sugar, the one weighed neat 17C. 3 qrs. 14l. at 2l. 6s. 8d. per C. the other weighed neat 18 C. 1 qr. 21l. at $4\frac{1}{4}$d. per l. which he mingleth together. now I desire to know how much a C. Weight of this Mixture is worth? *Answer*, 2l. 4s. 3d. $2\frac{3874}{4077}$ qr.

Quest. 31. Two Men, *viz.* *A*, and *B*, departed both from one Place, the one goes East, and the other West, the one travelleth 4 Miles a Day, the other 5 Miles a Day. How far are they Distant the 9th Day after their Departure? *Answer*, 81 Miles.

Quest. 32. *A* flying every Day 40 Miles, is pursued the 4th Day after by *B*, posting 70 Miles a Day, now the Question is in how many Days, and after how many Miles travel will *A* be overtaken?

Moor's Arith[illegible] *Chapter* 7. Ex. [illegible] *Answer*,

Answer, *B* overtakes him in 12 Days, when they have travelled 600 Miles.

11. The general Effect of the Rule of Three Direct, is contained in the Definition of the same, that is, to find a fourth Number in Proportion consisting of two equal Reasons, as hath been fully shewn in all the foregoing Examples.

The second Effect is, by the Price or Value of one Thing, to find the Price or Value of many Things of like Kind.

The third Effect is, by the Price or Value of many Things to find the Price of one, or by the Price of one to find the Price of many Things of like kind.

The fourth Effect is, by the Price or Value of many Things, to find the Price or Value of many Things of like Kind.

The fifth Effect is, thereby to reduce any Number of Moneys, Weight, or Measure, the one sort into the other, as in the Rules of Reduction contained in the 8th Chapter foregoing. Examples of its various Effects have been already answer'd.

12. The Rule of Three Direct is thus proved, *viz.* multiply the first Number by the fourth and note the Product then multiply the second Number by the third, and if this Product is equal to the Product of the first and fourth, then the Work is rightly performed, otherwise it is erroneous.

The Proof of the Rule of Three Direct.

So the first Question of this Chapter, (whose Answer or fourth Number we found to be 18s.) is thus proved, *viz.* the first Number is 4, which multiplied by 18 (the fourth) produceth 72. And the second and third Numbers are 12 and 6, which multiplied together produce 72, equal to the Product of the first and fourth; and therefore I conclude the Work to be rightly perform'd.

Always observing, that if any Thing remain after you have divided the Product of the 2d and 3d Numbers by the first, such Remainder in proving the same

must

must be added to the Product of the first and fourth Numbers, whose Sum will be equal to the Product of the 2d and 3d, (the 2d Number being of the same Denomination with the 4th and the 1st of the same Denomination with the 3d.)

So the fourth Question of this Chapter being again repeated, *viz.* If 14l. of Tobacco cost 27s. what will 478l. cost at that Rate? The Answer (or 4th Number was 46l. 01s. 10d. 1 qr. $\frac{2}{14}$ which is thus proved, *viz.* bring the fourth Number into Farthings, and it makes 44249, which multiplied by the first Number 14, produceth 619488 (the two which remain being added thereto) then (because I reduce my fourth Number into Farthings) I reduce my second (*viz.* 27s.) into Farthings, and they are 1296, which multiplied by the third Number 478, their Product is 619488 equal to the Product of the first and fourth Numbers. Wherefore I conclude the Operation to be true: This is an infallible Way to prove the *Rule of Three Direct*, and is deduced from the 12th *Section* of the 9th Chapter of this Book.

Thus much concerning the *Single Rule of Three Direct*. and I question not but by this Time the Learner is sufficiently qualified to resolve any Question pertinent to this Rule, not relying upon *Fractions* or *Geometrical Magnitudes*. Those that are desirous to see the Demonstration of this Rule, let them read the sixth Chapter of the ingenious Mr. *Kersey*'s Appendix to *Wingate*'s Arithmetic. Or the 6th Chapter of Mr. *Oughtreds* incomparable *Clavis Mathematica*: By both which Authors this Rule is largely demonstrated, being grounded upon the 19th *Prop.* of the 7th, and the 19th *Prop.* of the 9th of *Euclid's. Elem.*

CHAP. XI.

The Single Rule of Three Inverse.

1 THE *Golden Rule. or Rule of 3 Inverse* is when there are 3 *Numbers* given to find a fourth in such Proportion to the 3 given Numbers, as the fourth

proceeds from the second, according to the same Rate, Reason, or Proportion that the first proceeds from the third, or the Proportion is.

As the third Number is in Proportion to the second, so is the first to the fourth. *Alsted. Math. lib. 2. chap 14.*

So if the 3 Numbers given were 8, 12, and 16, and it were required to find a fourth Number in an inverted Proportion to these, I say that as 16, the third Number, is the Double of the first Term or Number, 8, so must 12, the second Number, be the Double of the fourth; so will you find the fourth Term or Number to be 6. And as in the Rule of 3 *Direct.* you multiply the second and third together and divide their Product for a fourth Proportional Number: So,

2. In the Rule of *Three Inverse* you must multiply the second Term by the first, or first Term by the second, and divide the Product thereof by the third Term, so the Quotient will give you the 4th Term sought in an inverted Proportion. The same Order being observed in this Rule as in the Rule of *Three Direct*, for placing and disposing of the given Numbers, and after your Numbers are placed in Order that you may know whether your Question be to be resolved by the Rule *Direct* or *Inverse*. Observe the general Rule following.

3. When your Question is stated, and your Numbers orderly disposed, Consider in the first Place whether the fourth Term or Number sought ought to be more or less than the second Term; which you may easily do: And if it is required to be more, or greater than the second Term, then the lesser Extreme must be your Divisor; but if it require less, then the biggest Extreme must be your Divisor. (in this Case the first and third Numbers are called Extremes in respect of the second, and having found out your Divisor, you may know whether your Question belong to the Rule *Direct* or *Inverse*; for if the third Term be your Divisor, then it is *Inverse*, but if the first Term be your Divisor, then it is a *Direct* Rule. As in the following Questions.

Quest.

Quest. 1. If 8 Labourers can do a certain Piece of Work in 12 Days, in how many Days will 16 Labourers do the same? *Answer* in 6 Days,

Having placed the Numbers according to the 6th Rule of the 10th Chapter, I consider that if 8 Men can finish the Work in 12 Days, 16 Men will do it in lesser (or fewer Days, than 12) therefore the biggest Extreme must be the Divisor, which is 16, and therefore it is the Rule of *Three Inverse*, wherefore I multiply the first and second Numbers together viz. 8 by by 12 and their Product is 96, which divided by 16 quotes 6 Days for the Answer, and in so many Days will 16 Labourers perform a Piece of Work, when 8 can do it in 12 Days.

lab. *days* *lab.*
8——12——16
8
——
16] 96 [6 *Days*
96
——
(0)
Facit 6 *Days*.

Quest. 2. If when the Measure, *viz.* a Peck of Wheat cost 2 Shillings, the Penny-Loaf weighed, according to the Statute, Standard, or Law of *England*, 8 Ounces, I demand how much it will weigh when the Peck is worth 1s 6d. according to the same Rate or Proportion? *Answer*, 10 Ounces 13 Penny weight, 8 Grains.

Having placed and reduced the given Numbers according to the 6th and 9th Rules of the 10th Chapter, I consider, that at 1s. 6d, per Peck, the Penny-Loaf will weigh more than 2 s. per Peck; for as the Price decreaseth, the Weight increaseth, and as the Price increaseth, so the Weight diminisheth, wherefore because the first Term requireth more than the second, the lesser Extreme must be the Divisor, 1s. 6d. or 18d. and having finished the Work, I find the Answer to be 10 oz. 13 p.w. 8 gr. and so much will the Penny-Loaf weigh when the Peck of Wheat is worth 1s. 6d. according to the given Rate of 8 Ounces, when the Peck is worth 2 Shillings; the Work is plain in the following Operation

s.	oz.	s.	d.
2	8	1	6
12	24	12	
24	32	18	
	16		

```
          16
        ————— oz. p.w. gr.
   18)  192 (10—13—8
        ..
        18
        ——
        (12)
         20
     ———————— p. w.
   18) 240     (13
       ..
       18
      ————
       60
       54
      ————
       (6)
       24
      ————
       24
       12
     ———— gr.
   18) 144  (8
       144
      ————
       (0)
```

Quest. 3. How many Pieces of Money or Merchandize at 20s. per Piece are to be given or received for 240 Pieces, the Value or Price of every Piece being 12 Shillings? *Answer*, 144. For if 12s. require 240 Pieces, then 20 Shillings will require less; therefore the biggest Extreme must be the Divisor, which is the third Number, *&c.* See the Work.

If

s. Pieces s.
If 12——240——20
12

480
240

2|0) 288|0 (144 *Pieces at* 20s. *per Piece.*
2

8
8

8
8

(0)

Quest. 4. How many Yards of 3 Quarters broad are required to double, or be equal in Measure to 30 Yards, that are 5 Quarters broad? *Answer*, 50 Yards. For say, if 5 Quarters wide require 30 Yards long, what length will three Quarters broad require? Here I consider that 3 Quarters broad will require more Yards than 30 for the narrower the Cloth is, the more in Length will go to make equal Measure with a broader Piece.

qrs—long——qrs.
5 30 3
5

3) 150 (50 yards
15

(0)

Quest. 5. At the Request of a Friend I lent him 200l. for 12 Months promising to do me the like Courtesie at my Necessity, but when I came to request it of him, he could let me have but 150l. now I desire to know how long I may keep this Money to make plenary Satisfaction for my former Kindness to my Friend? *Answer*, 16 Months. I say, if 200l. require 12 Months, what will 150l require? 150l will require more Time than 12 Months, therefore the lesser Extreme, *viz.* 150, must

must be the Divisor, multiply and divide, and you will find the fourth inverted Proportional to be 16, and so many Months I ought to keep the 150l. for Satisfaction.

Quest. 6. If for 24s. I have 1200l. Weight carried 36 Miles, how many Miles shall 1800l, be carried for the same Money? *Answer*, 24 Miles.

Quest. 7. If for 24s. I have 1200l. carried 36 Miles, how many Pound weight shall I have carried 24 Miles for the same Money? *Answer*, 1800l. Weight

Quest. 8. If 100 Workmen in 12 Days finish a Piece of Work or Service, how many Workmen are sufficient to do same in 3 days? *Answer*, 400 Workmen.

Quest. 9. A Colonel is besieged in a Town in which are 1000 Soldiers, with Provision of Victuals only for 3 Months, the Question is, how many of his Soldiers must he dismiss, that his Victuals may last the remaining Soldiers 6 Months? *Answer*, 500 he must keep and dismiss as many.

Quest. 10. If Wine worth 20l. is sufficient for the Ordinary of 100 Men when the Tun is sold for 30l. how many Men will the same 20 Pounds worth suffice when the Tun is worth 24l? *Answer* 125 Men.

Quest. 11. How much Plush is sufficient to line a Cloak which hath in it 4 Yards of 7 Quarters wide, when the Plush is but 3 Quarters wide? *Answer*, $9\frac{1}{3}$ Yards of Plush.

Quest. 12. How many Yards of Canvas that is Ell wide, will be sufficient to line 20 Yards of Say, that is 3 Quarters wide? *Answer*, 12 Yards.

Quest. 13. How many Yards of Matting that is two Foot wide, will cover a Floor that is 24 Foot long, and 20 Foot broad? *Answer*, 240 Foot.

Quest. 14. A Regiment of Soldiers consisting of 1000, are to have new Coats, and each Coat to contain 2 Yards, 2 Quarters of Cloth that is 5 Quarters wide, and they are to be lined with Shalloon that is 3 Quarters wide, I demand how many Yards of Shalloon will line them? *Answer*, $16666\frac{2}{3}$ Quarters of Yards, or $4166\frac{2}{3}$ Yards.

Quest.

Quest. 15. A Messenger makes a Journey in 24 Days, when the Days is 12 Hours long, I desire to know in how many Days he will go the same when the Day is 16 Hours long? *Answer*, in 18 Days.

Quest. 16. Borrowed of my Friend 63l. for 8 Months, and he hath Occasion another Time for to borrow of me for 12 Months, I desire to know how much I must lend to make good his former Kindness to me? *Answer*, 42l.

4 The general Effect of the Rule of 3 Inverse is contained in the Definition of the same, that is, to find a fourth Term in a reciprocal Proportion inverted to the Proportion given.

The second Effect is, by two Prices, or Values of 2 several Pieces of Money or Merchandize known, to find how many Pieces of the one Price is to be given for so many of the other. And consequently to reduce and exchange one sort of Money, or Merchandize into another. Or contrariwise, to find the Price unknown of any Piece given to exchange in reciprocal Proportion.

The third Effect is, by two differing Prices of a Measure of Wheat bought or sold, and the Weight of the Loaf of Bread, made answerable to one of the Prices of the Measure given, to find out the Weight of the same Loaf answerable to the other Price of the said Measure given. Or contrariwise, by the two several Weights of the same prized Loaf, and the Price of the Measure of Wheat answerable to one of those Weights given, to find out the other Price of the Measure answerable to the other Weight of the same Loaf.

The fourth Effect is, by 2 Lengths, and one Breadth of two rectangular Planes known, to find out another Breadth unknown. Or by two Breadths and one Length given, to find out another Length unknown in an inverted Proportion.

The fifth Effect is by double Time, and a capital Sum of Money, borrowed or lent, to find out another capital Sum answerable to 1 of the given Times. Or otherwise,

by

by two capital Sums, and a Time answerable to one of them given to find out a Time answerable to the other capital Sum in reciprocal Reason.

The sixth Effect, is by two differing Weights of Carriage, and the Distance of the Places in Miles or in Leagues given, to find another Distance in Miles answerable to the same Price of Payment: Or otherwise by two Distances in Miles, and the Weight answerable to one of the Distances (being carried for a certain Price) to find out the Weight answerable to the other.

The seventh Effect is, by double Workmen and the Time answerable to one of the Numbers of Workmen given, to find out the Time answerable to the other Number of Workmen, in the Performance of any Work or Service: Or contrariwise, by double Time, and the Workmen answerable to one of those Times given, to find out the Number of Workmen answerable to the other Time, in the Performance of any Work or Service.

Also by a double Price of Provision, and the Number of Men, or other Creatures nourished for a certain Time, answerable to one of the Prices of Provision given, to find out another Number of Men or other Creatures answerable to the other Price of the Provision for the same Time. Or contrariwise by 2 Numbers of Men or other Creatures nourished, and one Price of Provision answerable to one of the Numbers of Creatures given, to find out the other Price of the same Provision answerable to the other Number of Creatures, both being supposed to be nourished for the same, *&c.* As in the forgoing Examples is fully declared.

To prove the Operation of the Rule of 3 Inverse, multiply the 3d and 4th Terms together, and note their Product; and multiplying the 1st and 2d together, and if their Product is equal to the Product of the 3d and 4th, then is the Work truly wrought, but if it falleth otherwise, then it is erroneous.

As in the first Question of this Chapter, 16 (the 3d Number) being multiplied by 6 (the 4th Number the

Product

Product is 96, and the Product of 8, the first Number, multiplied by 12, the 2d Number, is 96, equal to the first Product, which proves the Work to be right.

And Note, that if in Division any Thing remain, such Remainder must be added to the Product of the 3d and 4th Terms, and if the Sum be equal to the Product of the 1st and 2d, the homogeneal Terms being of one Denomination, the Work is right.

CHAP. XII.

The Double Rule of Three Direct.

WE have already delivered the Rules of *Single Proportion*, and we come now to lay down the Rules of *Plural Proportion*.

1. *Plural Proportion*; is when more Operations in the Rule of Three than one are required before a Solution can be given to the Question propounded. Therefore in Questions that require Plurality in *Proportion*, there are always given more than Three Numbers.

2. When there are given 5 Numbers, and a 6th is required in Proportion thereunto, then this 6th Proportion is said to be found out by the double Rule of 3, as in the Question following, *viz*.

If 100l. in 12 Months gain 6l. Interest, how much will 75l. gain in 9 Months?

3. Questions in the double Rule of Three may be resolved either by two single Rules of Three, or by one single Rule of Three, compounded of the five given Numbers.

4. The double Rule of 3 is either *Direct*, or else *Inverse*.

5. The double Rule of 3 *Direct*, is when unto 5 given Numbers, a sixth Proportional may be found out by two single Rules of Three *Direct*.

9. The five given Numbers in the double Rule of Three consist of 2 Parts, *viz*. First, a Supposition; and Secondly,

Secondly, of a Demand; the Supposition is contained in the 3 first of the 5 given Numbers, and the Demand lies in the two last; as in the Example of the 2d Rule of this Chapter; *viz*. If 100l. in 12 Months gain 6l. Interest, what will 75l. gain in 9 Months? Here the Supposition is expressed in 100, 12, and 6; for it is said, if (or suppose) 100l. in 12 Months gain 6l, Interest, and the Demand lyeth in 75 and 9; for it is demanded how much 75l, will gain in 9 Months?

7. When your Question is stated, the next Thing will be to dispose of the given Numbers in due Order and Place, as a Preparative for Resolution; which that you may do, First, observe which of the given Numbers in the Supposition is of the same Denomination with the Number required; for that must be the second Number, in the first Operation, of the single Rule of 3, and one of the other Numbers in the Supposition it matters not which, must be first Number, and that Number in the Demand which is of the same Denomination with the first, must be 3d Number, which three Numbers being thus placed, will make one perfect Question in the single Rule of Three, as in the forementioned Example: First, I consider that the Number required in the Question, is the Interest or Gain of 75l. therefore that Number in the Supposition which hath the same Name (*viz*. 6l. which is the Interest or Gain of 100l.) must be the second Number in the first Operation, and either 100 or 12 (it matters not which) must be the first Number; but I will take 100, and then for the third Number, I put that Number in the Demand which hath the same Denomination with 100, which is 75, (for they both signifie Pounds principal) and then the Numbers will stand as you see in the Margin.

100—6—75

But if I had for the first Number put the other Number in the Supposition, *viz*. 12, which signifieth 12 Months,

Months, then the third Number must have been 9, which is that Number in the Demand which hath the same Denomination with the first, viz. 9 Months, and then they will stand as in the Margin.

12——6——9

There yet remain two Numbers to be disposed of, and those are, one in the Supposition, and another in the Demand; that which is of the Supposition, I place under the 1st of the 3 Numbers, and the other which is in the Demand I place under the 3d Number, and then 2 of the Terms in the Supposition will stand, one over the other, in the first Place, and the 2 Terms in the Demand will stand, one over the other, in the 3d Place, as in the Margin.

100——6——75
12 9

Or thus,

12——6——9
100 75

8. Having disposed, or ordered the Numbers given according to the last Rule, we may proceed to a Resolution, and first I work with the 3 uppermost Numbers, which according to the first Disposition are 100, 6, and 75, which is as much as to say, If 100l. require 6l. Interest, how much will 75l. require? which by the third Rule of the 11th Chapter I find to be Direct, and by the 7th and 8th Rules of the 10th Chap. I find the 4th Proportional Number to be 4l. 10s. so that by the foregoing single Question I have discovered how much Interest 75l. will gain in 12 Months, the Operation whereof followeth on the left Hand under the Letter *A*; and having discovered how much 75l. will gain in 12 Months, we may by another Question easily discover how much it will gain in 9 Months, for this fourth Number, thus found, I put in the Middle between the two lowest Numbers of the five, after they are placed according to the 7th Rule of this Chapter; and then it will be a second Number, in another Question in the Rule of Three, the Numbers

m. l. s. m.
being 12—4—10— 9 the 1st and 3d Numbers being of one Denomination, viz. both Months, and may be thus

thus expressed, if 12 Months require 4l. 10s. Interest, what will 9 Months require? And by the 3d Rule of the 11th Chapter, I find it to be the direct Rule and by working according to theDirections laid down in the 7, 8. and 9 Rules of the 10th Chapter I find the 4th Proportional Number, and is the Answer to the general Question. The Work of the last single Question is expressed on the right Side of the Page under the Letter B, as followeth,

100——6——75
12 9

A

l. l. l.
If 100——6——75
75
30
42
l. s.
1|00) 4|50 (4—10
4
Rem. (50)
Mult. 20
1|00) 10|00 (10s.
l. s.
Facit 4——10

B

Then say,
m. l. s. m.
If 12——4——10——9
20
90 *Shillings*
12
180
90
1080 *Pence*
9
——12)2|0 l. s. d.
12) 9720 (810(6|7--(3--7-6
6
96 71 7 s.
12 90
12 84
(0) (6) *Pence*
l. s. d.
Facit 3——7——6

So

So that by the foregoing Operation I conclude that if 100l. in 12 Months gain 6l. Intereſt, 75l. will gain 3l. 7s. 6d. in 9 Months after the ſame Rate.

The Anſwer would have been the ſame if the 5 given Numbers had been ordered according to the ſecond Method *viz.* as you ſee in the Margin.

12—6—9
100——75

For firſt, I ſay, if 12 Months gain 6l. what will 9 Months gain? This Queſtion I find to be Direct by the 3d Rule of the 11th Chapter, and by the 7 and 8 Rules of the 10th Chapter, I find the Fourth proportional Number to theſe three to be 4l. 10s.

Thus I have found out what is the Intereſt of 100l. for 9 Months, and I am now to find the Intereſt of 75l. for 9 Months; to effect which I make this 4th Number, found as before, to be my 2d Number in the next Queſtion, and ſay. If 100l. require 4l. 10s. what will 75l. require? This Queſtion I find by the ſaid 3d Rule of the 11th Chapter, to be Direct, and by the ſaid 7th, 8th, and 9th, Rules of the 10th Chapter, I find the Anſwer to be as before, *viz.* 3l. 7s. 6d.

This Rule hath been ſufficiently explained by the foregoing Example, ſo that the Learner may be able to reſolve the following, or any other Queſtion pertinent to the Double Rule of 3 Direct, whoſe Anſwers are there given, but the Operation purpoſely omitted to try the Learners Ability in the Knowledge of what hath been before delivered.

Queſt. 2. A Second Example in this Rule may be as followeth, *viz.* A Carrier receiving 42 Shillings for the Carriage of 5 *C* Weight 150 Miles, I Demand how much he ought to receive for the Carriage of 7 *C.* 3 qrs. 14l. 50 Miles at that Rate? *Anſwer*, 36s. 9d.

Queſt. 3. If a Regiment of 936 Soldiers eat up 351 Quarters of Wheat in 168 Days, I Demand how many Quarters of Wheat 11232 Soldiers will eat in 56 Days at that Rate? *Anſwer*, 1400 qrs.

Queſt. 4. If 40 Acres of Graſs be mowed by 8 Men in 7 Days, how many Acres ſhall be mowed by 24 Men in 28 Days? *Anſwer*, 480 Acres.

Quest. 5. If 48 Bushels of Corn, or other Seed yield 576 Bushels in 1 Year, how much will 240 Bushels yield in 6 Years at that Rate? That is to say, if there were allowed 240 Bushels every one of the 6 Years? *Answer,* 17280 Bushels.

Quest. 6. If 40 Shillings is the Wages of 8 Men for 5 Days, what shall be the Wages of 32 Men for 24 Days? *Answer,* 768 Shillings, or 38l. 8s.

Quest. 7. If 14 Horses eat 56 Bushels of Provender in 16 Days, how many Bushels will 20 Horses eat in 22 Days? *Answer,* 120 Bushels.

Quest. 8. If 8 Cannons in 1 Day spend 48 Barrels of Powder, I Demand how many Barrels 24 Cannons will spend in 12 Days at that Rate? *Answer,* 1728 Barrels.

Quest. 9. If in a Family consisting of 7 Persons, there are drunk out 2 Kilderkins of Beer in 12 Days, how many Kilderkins will there be drunk out in 8 Days by another Family consisting of 14 Persons? *Answer,* 48 Gallons, or 2 Kilderkins and 12 Gallons.

Quest. 10. An *Usurer* put 75l. out to receive Interest for the same, and when it had continued 9 Months he received for Principal and Interest 78l. 7s. 6d. I demand at what Rate *per Cent per Annum* he received Interest? *Answer,* at 6l *per Cent per Annum.*

CHAP. XIII.

The Double Rule of Three Inverse.

1. THE Double Rule of 3 Inverse, is, when a Question in the Double Rule of 3 is resolved by 2 Single Rules of 3, and 1 of those Single Rules falls out to be Inverse, or requires a Fourth Number or Proportion reciprocal, for both the Questions are never Inverse.

2. In all Questions of the Double Rule of 3, as well Inverse as Direct, you are, in the disposing of the 5 given

given Numbers, to observe the 7th Rule of the 12th Chapter, and in resolving of it by 2 Single Rules observe to make Choice of your Numbers for the first and second Single Questions according to the Directions given in the eighth Rule of the same Chapter, as in the Example following *viz.*

Quest. 1. If 100l. Principal in 12 Months gain 6l. Interest, what Principal will gain 3l. 7s. 6d. in 9 Months?

This Question is an Inversion of the first Question of the 12th Chapter, and may serve for a Proof thereof.

In Order to a Resolution, I dispose the 5 given Numbers according to the 7th Rule of the 1st Chapter, and being so disposed, will stand as followeth.

12 ——— 100 ——— 9
l. l. s. d.
6 ——— 3 — 7 — 6

Or thus,

l. l. s. d.
6 ——— 100 ——— 3 — 7 — 6
12 9

Here, Observe that according to the 8th Rule of the 12th Chapter, the 1st Question, If you take it from the 5 Numbers, as they are ordered or placed first, will be, If 12 Months require 100l. Principal, what will 9 Months require to make the same Interest? This (according to the 3d Rule of the 11th Chapter) is Inverse and the Answer will be found by the 2d Rule of the 11th Chapter, to be 133l. 6s. 8d. the 2d Question then will be, If 6l. Interest, require 133l. 6s. 8d. Principal, how much Principal will 3l. 7s. 6d. require? This is a Direct Rule, and the Answer in a Direct Proportion is 75l. See the Work.

First I say,

```
       m.          l.        m.
If 12 ———— ————100————————9
                12
            ———————— l.    s.    d.
         9) 1200 (133——6——8
              ..
               9
            ———————
              30
              27
            ———————
               30
               27
              ———————
               (3)
                20
              ———————
             9) 60 (6s.
                54
              ———————
                 (6)
                 12
               ———————
              9) 72 (8d.
                 72
               ———————
                  (0)
```

Then

Then I say,

```
    l.      l.     s.    d.       l.    s.    d.
If  6 ---- 133 --- 6 --- 8 ------ 3 --- 7 --- 6
   240      20                    20
  ------  -----                 -----
  1440d.   2666                   67
             12                   12
         --------               -----
          5340                   140
         2666                     67
        ------                  -----
         32000                   810d.
           810
         -----
        320000
       256
  --------------- 24|0
144|0) 2592000|0 (1800|0 (75l.

       144        168
      -----      -----
      1152        129
      1152        120
      -----      -----
       (0)        (0)
```

Jane [illegible]

So that by the foregoing Work I find that if 6l. Interest be gained by 100l. in 12 Months, 3l. 7s. 6d. will be gained by 75l. in 9 Months.

But if the Resolution had been found out by the Numbers as they are ranked in the second Place, then the second Question in the Single Rule would have been Inverse, and the first Question Direct, and the Conclusion the same with the first Method, viz. 75l.

Quest. 2. If a Regiment consisting of 936 Soldiers, can eat up 351 Quarters of Wheat in 168 Days, how many Soldiers will eat up 1400 Quarters in 56 Days at that Rate? *Answer.* 11232 Soldiers.

Quest. 3. If 12 Students in 8 Weeks spend 48l. I Demand how many Students will spend 288l. in 18 Weeks? *Answer,* 32 Students.

N 3 *Quest.*

Quest. 4. If 48l. serve 12 Students 8 Weeks, how many Weeks will 288l. serve 4 Students? *Answer*, 144 Weeks.

Quest. 5. If when the Bushel of Wheat cost 3s. 4d. the Penny Loaf weigheth 12 Ounces, I Demand the Weight of the Loaf worth 9d. when the Bushel cost 10s. *Answer* 36 Ounces,

Quest. 6. If 48 Pioneers in 12 Days cast a Trench 24 Yards long, how many Pioneers will cast a Trench 168 Yards long in 16 Days? *Answer*, 252 Pioneers.

Quest. 7. If 12 *C.* Weight being carried 100 Miles cost 5l. 12s. I desire to know how many *C.* Weight may be carried 150 Miles for 12l. 12s. at that Rate? *Answer*, 18 *C.*

Quest. 8. If when Wine is worth 30l. *per Tun*, 20l. worth is sufficient for the Ordinary of 100 Men, how many Men will 4l. worth suffice when it is worth 24l. *per Tun*? *Answer*, 25 Men.

Quest. 9. If 6 Men in 24 Days mow 72 Acres, in how many Days will 8 Men mow 24 Acres? *Answer*, in 6 Days.

Quest. 10. If when the Tun of Wine is worth 30l. 100 Men will be satisfied with 20l. worth, I desire to know what the Tun is worth when 4l. worth will satisfie 25 Men at the same Rate? *Answer*, 24l. *per Tun*.

CHAP. XIV.

The Rule of Three composed of five Numbers.

1. THE Rule of Three Composed, is, when Questions (wherein there are 5 Numbers given to find a 6th in Proportion thereunto) are resolved by 1 single Rule of 3 Composed of the 5 given Numbers.

2. When Questions may be performed by the double Rule of 3 Direct, and it is required to resolve them by the Rule of 3 Composed, (first order or rank your Numbers

Numbers according to the 7th Rule of of the 12th Chapter, then.)

The Rule is

Multiply the Terms or (Numbers) that stand one over the other, in the first place, the one by the other, and make their Product the first Term in the Rule of Three Direct, then Multiply the Terms that stand one over the other, in the third Place, and place their Product for the third Term in the Rule of Three Direct, and put the middle Term of the three uppermost for a second Term; then having found a fourth Proportional, Direct to these Three, this fourth Proportional so found, shall be the Answer required.

So the first Question of the 12th Chapter being proposed, *viz.* If 100l. in 12 Months gain 6l Interest, what will 75l gain in 9 Months? The Numbers being ranked (or placed) as is there directed and done.

Then I Multiply the 2 first Terms, 100 and 12, the one by the other, and their Product is 1200 (for the first Term; then I Multiply the 2 last Terms 75 and 9 together, and their Product is *675*, for the 3d Term. Then I say, as 1200 is to *6*, so is *675* to the Answer, which by the Rule of Three Direct will be found to be 3l 7s 6d. as was before found.

But if the Question be to be answered by the double Rule of Three Inverse then (having placed the 5 given Terms as before) Multiply the lowermost Term of the first Place, by the uppermost Term of the third Place and put the Product for the first Term; then Multiply the uppermost Term of the first Place, by the lowermost Term of the third Place, and put the Product for the third Term, and put the second Term of the three highest Numbers for the middle Term to those two: Then if the Inverse Proportion is found in the uppermost Three Numbers, the 4th Proportional Direct to these Three shall be the Answer; so the first Question of the 13th Chapter being stated, *viz.* If 100l. Principal in 12 Months gain 6l. Interest,

terest. what Principal will gain 3l. 7s. 6d. in Nine Months? State the Numbers as is there directed in the first Order, *viz.*

M.	l.	M.		
12 ——	100 ——	9		
l.		l.	s.	d.
6		3 ——	7 ——	6

then reduce the 5l. and 3l. 7s. 6d. into Pence, the 6l. is 1440d. and 3l. 7s. 6d. is 810d. then Multiply 1440 by 9, the Product is 12960 for the first Term in the Rule of Three Direct, and Multiply 810 by 12, the Product is 9720 for the third Term, then I say, As 12960 is to 100l. so is 9720 to the Answer, *viz.* 75l. as before. But if the Terms had been placed after the second Order, *viz.*

l.	l.	l.	s.	d.
6 ——	100 ——	3 ——	7 ——	6
M.		M.		
12		9		

then the Inverse Proportion is found in the lowest Numbers, and having composed the Numbers for a single Rule of Three as in the second Rule foregoing then the Answer must be found by a single Rule of Three Inverse; for here it falls out to Multiply 810 by 12 for the first Number, and 1440 by 9 for the third Number, and then you must say, As 9720 is to 100l. so is 12960 to the Answer, which by Inverse Proportion will be found to be 75l. as before.

The Questions in the 12th and 13 Chapters may serve for thy farther Experience.

CHAP. XV.

Single Fellowship.

1. FELLOWSHIP is that Rule of Plural Proportion, whereby we ballance Accompts, depend-

ing

ing between divers Persons having put together a general Stock. so that they may every Man have his Proportional Part of Gain, or sustain his Proportional Part of Loss.

2. The Rule of Fellowship is either Single, or it is Double.

3. The Single Rule is when the Stocks propounded are Single Numbers without any Respect or Relation to Time, each Partner continuing his Money in Stock for the same Time.

4. In the Single Rule of Fellowship, the Proportion is: As the whole Stock of all the Partners is in Proportion to the total Gain or Loss: so is each Mans particular Share in the Stock, to his particular Share in the Gain or Loss. Therefore take the Total of all the Stocks for the first Term in the Rule of Three and the whole Gain or Loss for the second Term, and the particular Stock of any one of the Partners for the third Term, then Multiply and Divide according to the 7th Rule of of the 9th Chapter, and the 4th Proportional Number is the particular Loss or Gain of him whose Stock you made your third Number: Wherefore repeat the Rule of 3 as often as there are particular Stocks, or Partners in the Question, and the 4th Terms produced upon the several Operations are the respective Gain or Loss of those particular Stocks given; as in the Examples following.

Quest. 1. Two Persons *viz.* A, and B; bought a Tun of Wine for 20l. of which A paid 12l. and B paid 8l. and they gained in the Sale thereof 5l. now I Demand each Mans Share in the Gain according to his Stock?

First, I find the Sum of their Stocks, by adding them together, *viz.* 12l. and 8l.

which are 20l. then according to	12
this Rule I say first, If 20l. (the	8
Sum of their Stocks) require 5l.	——
the Total Gain, how much will 12l.	20l.
(the Stock of A) require? Multi-	

ply and Divide by the 7th Rule of the Ninth Chapter

ter, and the Answer is 3l. for the Share of A in the Gains; then, again I say, If 20l. require 5l. what will 8l. require? The Answer is 2l. which is the Gain of B. So I conclude that the Share of A in the Gain is 3l. and the Share of B in the Gain is 2l. which in all is 5l.

```
       l.        R        l.
If 20 ———— 5 ———— 12
                12
            ————
      20)  60 (3l.
           60
            ————
            (0)

       l.        l.        l.
If 20 ———— 5 ———— 8
                8
            ————
      20)  40 (2l.
```

Quest. 2. Three Merchants, *viz.* A, B, and C, enter upon a joint Adventure, A put into the common Stock 78l. B put in 117l. and C put in 234l. and they find (when they make up their Accompts) that they have gained in all 264l. now I desire to know each Mans particular Share in the Gains?

First I add their particular Stocks together, and their Sum is 429l. then say, If 429l. gain 264l. what will 78l. gain? and what 117l. and what will 234l. (the Stocks of A, B. and C) gain? Work by 3 several Rules of 3, and you will find that

	l.
	78
	117
	234
Sum	429

$$\text{The Gain of} \left\{ \begin{array}{c} A \\ B \\ C \end{array} \right\} \text{is} \left\{ \begin{array}{r} 48 \\ 72 \\ 144 \end{array} \right. \quad \text{l.}$$

Sum 264.

Quest.

Quest. 3. Four Partners, *viz.* A, B, C, and D, between them built a Ship which cost 1730l. of which A paid 346l. B 519l. C 692l. and D 173l. and her Freight for a certain Voyage is 370l. which is due to the Owners or Builders, I Demand each Mans Share therein according to his Charge in Building her.

Answer,

	l.
A	74
B	111
C	148
D	37
Sum	370

Quest. 4. A, B and C, enter Partnership for a certain Time, A, put into the common Stock 364l. B, put in 482l. C, put in 500l. and they gained 867l. now I demand each Mans Share in the Gain proportional to his Stock.

Answer,

	l.	s.	d
A	234	09	$3\frac{354}{1346}$
B	310	09	$5\frac{86}{1346}$
C	322	01	$3\frac{930}{1346}$
Sum	867	00	0

5. To prove the Rule of *Single Fellowship*, add each Mans particular Gain or Loss together and if the Total Sum is equal to the general Gain or Loss, then is the Work rightly performed but, otherwise it is erroneous. Example. In the first Question of this Chapter, the *Answer* was that the Gain of A was 3l. and the Gain of B 2l. which added together make 5l. equal to the Total given.

The Proof of the Rule of Single Fellowship.

If in finding out the *particular shares* of the several *Partners*, any Thing remain after Division is ended, such

such Remainders must be added together (they being all Fractions of the same Denomination) and their Sum divided by the common Divisor in each Question (*viz.*, the Total Stock) and the Quotient add to the *Particular Gains*, and then if the Total Sum is equal to the Total Gain the Work is right, otherwise not.

As in the Fourth Question, the Remainders were 354.62, and 930, which added together make 1346 which divided by 1346. (the Sum of their Stocks) the Quotient is 1d. which I add to the Pence *&c.* and the Sum of their Shares is 867l. equal to the Total Gain; wherefore I conclude the Work is right.

CHAP. XVI.

Double Fellowship.

1 DOUBLE Fellowship is when several Persons enter into *Partnership* for unequal Time, that is, when every Mans *Particular* Stock hath Relation to a *Particular* Time.

2. In the Double Rule of Fellowship, Multiply each *Particular* Stock by its respective Time, and having added the several Products together make their Sum the first *Number* or *Term*, in the Rule of 3, and the Total Gain or Loss the second Number, and the Product of any one particular Stock by his Time the third *Term* and the 4th *Number* in *Proportion* thereunto is his *Particular* Gain or Loss, whose Product of Stock and Time is your third *Number*.

Then repeat, as in Single Fellowship, the Rule of 3 as often as there are Products or Partners, and the 4 *Terms* thereby invented are the *Numbers* required *Example*.

Quest. 1. A and B enter *Partnership*. A put in 40l. for 3 Months, B put in 75l. for 4 Months, and they gained

gained 70l. now I demand each Mans Share in the Gains, proportionable to his Stock and Time? *Answer*, A 20l. B 50l.

To resolve this Question, I first multiply the Stock of A, (*viz.* 40l.) by its Time (3 Months) and the Product is 120, then I multiply the Stock of B by its Time (*viz.* 75 by 4) and it produceth 300, which I add to the Product of A his Stock and Time, and the Sum is 420. Then by the Rule of 3 Direct, I say, As 420 (the Sum of the Products) is to 70

l.		l.	
40		75	
3		4	
120	A	300	B
		120	
	Sum	420	

the Total Gain, so is 120, the Product of A his Stock and Time, to 20l. the Share of A in the Gains, and so is 300 the Product of B his Stock and Time, to 50l. the Share of B in the Gains. And so much ought each to have for his Share.

Quest. 2. A. B. and C. make a Stock, for 12 Months, A put in at first 364l. and 4 Months after, he put in 40l. B put in at first 408l. and at the End of 7 Months he took out 86l. C put in at first 148l and 3 Months after he put in 86l. more, and 5 Months after that he put in 100l. more, and at the End of 12 Months their Gain is found to be 1436l. I desire to know each Mans Share in the Gains according to his Stock and Time?

First I consider, that the whole Time of their Partnership is 12 Months. Then I proceed to find out the several Products of Stock and Time as followeth,

A had at first 364l. for 4 Months, wherefore their Product is,	1456
Then he put in 40l. which with the first Sum makes 404l. which continued the Remainder of the Time, *viz.* 8 Months, and their Product is,	3232
The Sum of the Products of the Stock and Time of A is	4688

B had 408l in 7 Months, whose Product is	2856
And then took out 86l. therefore he left in Stock 322l. which continued the rest of the Time, *viz.* five Months, whose Product is	1610
The Sum of the Products of the Stock and Time of B is	4466
C put in 148l for 3 Months, whose Product being multiplyed is	444
Then he put in 86l. which added to the first, *viz.* 148, makes 234l which lay in Stock 5 Months, their Product is	1170
Then he put in 100l. more, so then he had in Stock 334l. which continued the Remainder of the Time, *viz.* 4 Months, which multiplyed together produce	1336
The Sum of the Products of the Money and Time of C is	2950
B	4466
A	4688
The Total Sum of all the Products is	12104

Then I say, as 12104 is to 1436, the Total Gain, so is 4688 to the Share of A in the Gains, &c, go on as in the foregoing Example's and you will find their Shares in the Gain to be as followeth, *viz.*

Answer,

The Share of		is	
	A		556—03—6 $\frac{610}{12104}$
	B		529—16—9 $\frac{5486}{12104}$
	C		349—19—8 $\frac{418}{12124}$
		Sum	1436—00—0

Quest. 3. Three Grasiers, A B and C, take a piece of Ground

Ground for 46l. 10s. in which A put in 12 Oxen for 8 Months, B put in 16 Oxen for 5 Months, and C put 18 Oxen for 4 Months, now the Question is, what shall each Man pay of the 46l. 10s. for his Share in that Charge?

Answer,

		l.	s.
A	shall pay	18	00
B		15	00
C		13	10
		46	10

3. The Proof of this Rule is the same with that of *Single Fellowship*, laid down in the 5th Rule of the 5th Chapter; and note that,

If a Loss be sustained instead of Gain amongst Partners, every Mans Share to be born in the Loss is to be found after the same Method as their Gain, whether their Stocks be for equal or unequal Time.

CHAP. XVII.

Alligation Medial.

1. THE Rule of Alligation is that Rule in plural Proportion, by which we resolve Questions, wherein is a Composition or Mixture of divers Simples, also it is useful in the Composition of Medicines both for Quantity, Quality, and Price. And its species are two, *viz.* Medial and Alternate.

2. Alligation Medial is when having the several Quantities and Prices of several simples propounded we discover the mean Price or Rate of any Quantity of Mixture compounded of those Simples, and the Proportion is, as the Sum of the Simples, to be mingled, is to the Total Value of all the Simples, so is any Part

Part or Quantity of the Composition or Mixture to its mean Rate or Price.

Quest. 1. A Farmer mingleth 20 Bushels of Wheat at 5s. per Bushel, and 36 Bushels of Rye at 3s per Bushel, with 40 Bushels of Barley, at 2s per Bushel, now I desire to know what 1 Bushel of that Mixture is worth?

To resolve this Question add together the given Quantities and also their Values, which is 96 Bushels, whose Total Value is 14l. 8s. as appeareth by the Work following; for,

Bushels			l.	s.
20 of Wheat	at 5s. per Bushel, is		5	0
36 of Rye	at 3s. per Bushel, is		5	8
40 of Barley	at 2s. per Bushel, is		4	0
The Sum of the given Quantities is 96	and their value is		14	8

Then say by the Rule of 3 Direct, If 96 Bushels cost, (or is worth) 14l. 8s. what is 1 Bushel worth?

b. l. s. b.
96——14——8——1
20

96) 288 (3s.
288
——*fac.* 3s. *per Bush.*
(0)

Quest. 2. A Vintner mingleth 15 Gallons of Canary at 8s. per Gallon, with 20 Gallons of Malaga at 7s 4d. per Gallon, with 10 Gallons of Sherry at 6s. 8d. per Gallon, & 24 Gallons of White Wine at 4s. per Gallon, now I demand what a Gallon of that Mixture is worth? Work as in the last Question, and you will find the Answer to be 6s. 2d. 2 qrs. $\frac{6}{69}$.

Quest. 3. A Grocer hath mingled 3C. of Sugar at 56s. per C. with 3C. of Sugar at 3l. 14s. 8d. per C. and with 6 C. at 1l. 17s. 04d. per C. I desire to know the Price

Price of a Hundred Weight of that Mixture?

Answer, 2l. 11s. 4d.

3. The Proof of this Operation is by the Price of any Quantity of the Mixture to find out the Total Value of the whole Composition, and if it is equal to the Total Value of the several Simples, the Work is right, otherwise not. As in the first Example, the Answer to the Question was that 3s. is the Price of one Bushel; wherefore I say by the Rule of Proportion, If 1 Bushel be 3 Shillings, what is 96 Bushels? *Answer*, 14l. 8s. which is the Total Value of the several Simples, wherefore the Work is right.

The Proof of Allig. Medi.

CHAP. XVIII.

Alligation Alternate.

1. ALLIGATION Alternate is when there are given the particular Prices of several Simples, and thereby we discover such Quantities of those Simples, as being mingled together shall bear a certain Rate propounded.

2. When such a Question is stated, place the given Prices of the Simples one over the other, and the propounded Price of the Composition against them in such sort that it may represent a Root, and they so many Branches springing from it, as in the following Example.

Quest. 1. A certain Farmer is desirous to mix 20 Bushels of Wheat at 5s, or 60d. per Bushel, with Rye at 3s. or 36d. per Bushel, and with Barley at 2s. or 24d. per Bushel, and Oats at 1s. 6d. per Bushel, and desireth to mix such a Quantity of Rye, Barley and Oats with the 20 Bushels of Wheat, as that the whole Composition may be worth 2s. 8d. or 32d. per Bushel.

The Prices of the Simples being p'aced according to the last Rule, with the Price of Composition propounded as a Root to them will stand as followeth.

$$32\begin{cases}60 \text{ Pence.}\\36\\24\\18\end{cases}$$

3. Having thus placed the given Numbers, you are to link or combine the several Rates of the Simples the one to the other, by certain Arches. in such a sort that one that is lesser than the Root, or mean Rate, may be linked or coupled to another that is greater than the mean Rate, so the Question last propounded will stand.

1. *Thus*,

$$32\begin{cases}60\\36\\24\\18\end{cases}$$

2. *Or Thus*;

$$32\begin{cases}60\\36\\24\\18\end{cases}$$

3. *Or Thus*:

$$32\begin{cases}60\\36\\24\\18\end{cases}$$

4. Then take the Difference between the Root and the several Branches, and place the Difference of each against the Number or Branch, with which it is coupled or linked and having taken all the Differences and placed them as aforesaid, then those Differences so placed will shew you the Number of each Simple to be taken to make a Composition to bear the mean Rate compounded

So the Branches of the last Question being linked together as in the first Manner, I say the Difference between 32 and 60. is 28; which I put against 18. because 60 is linked with 18, then the Difference between 32 and 36 is 4. which I put against 24 because 36 is linked or

$$32\begin{cases}60\\36\\24\\18\end{cases}\left|\begin{matrix}14\\8\\4\\28\end{matrix}\right.$$

coupled

coupled with 24, then I ſay the Difference between 32 and 24 is 8, which I place againſt 36, for the Reaſon aforeſaid, then I ſay the Difference between 32 and 18 is 14, which I place againſt 60; and then the Work will ſtand as you ſee in the Margin.

So I conclude that a Compoſition made of 14 Buſhels of Wheat at 60d. per Buſhel, and 8 Buſhels of Rye at 36d per Buſhel, and 4 Buſhels of Barley at 24d. per Buſhel, and 28 Buſhels of Oats at 18d. per Buſhel, will bear the mean Price of 32d. or 2s. 8d. per Buſhel. And here obſerve that in this Compoſition there is but 14 Buſhels of Wheat; but I would mingle 20 Buſhels, and this kind or rather caſe of Alligation Alternate, *viz.* when there is given a certain Quantity of one of the Simples, and the Quantities of the reſt ſought to mingle with this given Quantity, that the whole may bear a Price propounded, is called Alternation partial.

And the Proportion to find out the ſeveral Quantities to be mingled with the given Quantity is as followeth, *viz.*

As the Difference annexed to the Branch that is the Value of an Integer of the given Quantity is to the other particular Differences, ſo is the Quantity given to the ſeveral Quantities required.

So here to find out ſo much Rye, Barly and Oats as muſt be mingled with the 20 Buſhels of Wheat, I ſay by the ſingle Rule of 3 Direct, if 14 Buſhels of Wheat require 8 Buſhels of Rye, what will 20 Buſhels of Wheat require? *Anſwer*, $11\frac{6}{14}$ Buſhels of Rye.

Again if 14 Buſhels of Wheat require 4 Buſhels of Barley, what will 20 Buſhels of Wheat require? *Anſwer*, $5\frac{10}{14}$ Buſhels of Barley. Again I ſay, if 14 Buſhels of Wheat require 28 Buſhels of Oats what will 20 Buſhels of Wheat require? *Anſwer*, 40 Buſhels of Oats.

And now I ſay, that 20 Buſhels of Wheat mingled with $11\frac{6}{14}$ Buſhels of Rye, and $5\frac{10}{14}$ Buſhels of Barley, and 40 Buſhels of Oats each bearing the Rates as aforeſaid, will make a Compoſition or Heap of Corn that may yield 32d. per Buſhel.

But if the Branches had been coupled according to the

the 2d Order, or Manner the Differences would have been thus placed *viz.* the Difference between 32 & 60 is 28 which I set against 24, because 60 is linked thereto; and the Difference between 32 and 36 is 4, which I set against 18, and the Difference betwixt 32 and 24 is 8, which I set against 60; then the Difference between 32 and 28 is 14, which I set against his Yoke-fellow 36, and then I conclude that if you mix 8 Bushels of Wheat with 14 Bushels of Rye, 28 Bushels of Barley, and 4 Bushels of Oats, each bearing the aforesaid Prices, the whole Mixture may be sold for 32d. per Bushel as by the Work in the Margin.

32	60	8
	36	14
	24	28
	18	4
		54

You see by this Work, we have found how many Bushels of Rye, Barley and Oats, ought to be mixed with 8 Bushels of Wheat, and to find out how many of each ought to be mixt with 20 Bushels of Wheat, I say, as 8 is to 14, so is 20 to 35 Bushels of Rye. As 8 is to 28, so is 20 to 70 Bushels of Barley. As 8 is to 4, so is 20 to 10 Bushels of Oats, whereby I conclude, that if to 20 Bushels of Wheat I put 35 Bushels of Rye; 70 Bushels of Barley, and 10 Bushels of Oats, bearing each the foresaid Prices per. Bushel, that then a Bushel of this Mixture will be worth 32d. or 2s. 8d.

And if the Branches had been linked as you see in the 3d Place, where each Branch bigger than the Root is linked to 2 that are lesser then the Root then in this case you must have placed the several Differences between the Root and Branches, against those 2 with which each is coupled as at first the Difference between 32 and 60 is 28 which I put against 24 and 18 because it is coupled with 'em both then the Difference between 32 & 36 is 4, which I set likewise against 24 and and 18 because 36 is linked to them both, then the Difference between 32 and 24 is 8, which I put against 60 and 36, because 24 is linked to them both, then the

32	60	8	1	22
	36	8	1	22
	24	28	4	32
	18	28	4	32

Dif-

Difference between 32 and 18 is 14, which I put against 60 and 36, the Yoke-Fellows of 18.

Laſtly, I draw a Line behind the Differences, and add the Differences which ſtand againſt each Branch, and put the Sum behind the ſaid Line againſt its proper Branch, as you ſee in the Margin.

And now by this Work I find that 22 Buſhels of the Wheat mingled with 22 Buſhels of Rye, and 32 Buſhels of Barley, and 32 Buſhels of Oats, each bearing the ſaid Price will make a Mixture bearing the mean Rate of 32d. per Buſhel.

And now to find how much of each of the reſt muſt be mingled with 20 Buſhels of Wheat, I ſay,

As 22 is to 22, ſo is 20 to 20 Buſhels of Rye. As 22 is to 32, ſo is 20 to 29 $\frac{2}{22}$ Buſhels of Barley, As 22 is to 32, ſo is 20 to 29 $\frac{2}{22}$ Buſhels of Oats.

Whereby you ſee the Queſtions of Alligation Alternate will admit of more true Anſwers than one; for we have found Three ſeveral Anſwers to this firſt Queſtion.

Queſtions of Alternation Partial are proved the ſame way with Queſtions in Alligation Medial, which you may ſee in the 3d Rule of of the 17th Chapter.

The Proof of Alternation partial

Queſt. 2. A Grocer hath 4 ſorts of Sugar, *viz.* of 12d. per l. of 10d. per l. of 6d. per l. and of 4d. per l. and he would have a Compoſition worth 8d. per l. the whole Quantity whereof ſhould contain 144l. made of theſe 4 Sorts, I demand how much of each he muſt take?

Queſtions of this Nature are reſolved by that part of Alligation Alternate called by Arithmeticians Alternation Total, *viz.* where there is given the Sum, and Prices of ſeveral Simples to find out how much of each Simple ought to be taken to make the ſaid Sum or Quantity, ſo that it may bear a certain Rate propounded.

To reſolve this Queſtion I place the ſeveral Prices of the Simples and mean Rate propounded, and link

them together as directed in the 2d and 3d Rules of this Chapter, and place the Differences between the Root and Branches according to the 4th Rule of this Chapter, which will then stand one of these three Ways, *viz.*

First.

8	12	4
	10	2
	6	2
	4	4
		12

Second.

8	12	2
	10	4
	6	4
	4	2
		12

Third.

8	12	2,4	6
	10	2 4	6
	6	4,2	6
	4	4,2	6

5. Then add the several Differences together, which I have done, and the Sums of the first and second Order are 12l. and of the third 24l. as you may see above, but it is required that there should be 144l. of the Composition, therefore to find the Quantity of each Simple to make the whole Composition 144l. observe this general Rule, *viz.*

As the Sum of the Differences is to several Differences, so is the total Quantity of the Composition to the Quantity of each Simple.

So to find how much of each sort of Sugar I ought to take to make 144l. at 8d. per l. I say,

								l.			
As	12	is	to	4,	so is	144	to	48l.	at	12d.	per l.
As	12	is	to	2,	so is	144	to	24l.	at	10d.	per l.
As	12	is	to	2,	so is	144	to	24l.	at	6d.	per l.
As	12	is	to	4,	so is	144	to	48l.	at	4d.	per l.

Where-

Whereby I find that 48l. at 12d. per l. and 24l. at 10 d. per l. and 24l. at 6d. per l. and 48l. at 4d. per l. will make a Composition of Sugar containing 144 l. worth 8d. per l.

But as the Branches are linked in the second Order the Answer will be 24l. at 12d. per l. and 48l. at 10d. per l. and 48 l. at 6d. per l. and 24 l. at 4d. per l. to make the said Quantity, and to bear the said Price.

And if you had worked as the Branches are linked after the third Order, then you would have found the Quantity of 36l. of each.

Quest. 3. A Vintner hath 4 Sorts of Wine, *viz.* Canary at 10 s. per Gallon, Malaga at 8 s. per Gallon; Rhenish-wine at 6 s. per Gallon; and White-wine at 4 s. per Gallon, and he is minded to make a Composition of them all of 60 Gallons that may be worth 5 Shillings per Gallon, I desire to know how much of each he must have?

The Numbers of Terms being ranked according to the second Rule of this Chapter, the Branches will be linked as followeth, and will admit of no other Manner of Coupling, because there is but one Branch that is lesser than the Root, therefore all the Rest must be linked unto it; and the Differences between the Root and the three first Branches, *viz.* 10, 8, and 7, which are 5, 3, and 1, must be set against 4 because they are all coupled with it, and the Difference between the Root, (*viz.* 5.) and 4 which is 1, must be set against the 3 other, because it is linked to them all; so I find 1 Gallon of Canary, 1 Gallon of Malaga, 1 Gallon of Rhenish-wine, and 9 Gallons of White-wine, prized as above being mingled together, will be worth 5 s. per Gallon, the Sum being 12 Gallons, but there must be 60 Gallons; wherefore I say,

5	10	1	1
	8	1	1
	6	5	1
	4	5,3,1,	9
			12

As 12 is to 1, so is 60 to 5 Gallons of Canary,
As 12 is to 1, so is 60 to 5 Gallons of Malaga.
As 12 is to 1, so is 60 to 5 Gallons of Rhenish.
As 12 is to 9, so is 60 to 45 Gallons of White-wine.

So

So that 5 Gallons of Canary, 5 Gallons of Malaga, 5 Gallons of Rhenish and 45 Gallons of White-wine mingled together, will be in all 60 Gallons, worth 5s. per Gallon, which was required.

Quest. 4. A Goldsmith hath Gold of four several Sorts of Fineness, *viz.* of 24 Carects fine, and of 22 Carects fine, of 20 Carects fine, and of 15 Carects fine. And he would mingle so much of each with Alloy, that the whole Mass of 28 Ounces of Gold so mingled may bear 17 Carects fine. I demand how much of each he must take, the Second and Third Rules of this Chapter being observed, (but instead of the Alloy, I put 0, because it bears no Fineness, but it makes a Branch in the Operation) the Terms may be alligated and the Differences added any of these 4 Ways following, *viz.*

Read Chap. 2. *def.* 2. *of this Book.*

First thus,

17	24	17	17
	22	2	2
	20	2 17	19
	15	5, 3	8
	0	7, 3	10
		Sum	56

Secondly thus,

17	24	2	2
	22	17	17
	20	2, 17	19
	15	7, 3	10
	0	5, 3	8
		Sum	56

Thirdly thus,

17	24	2,	2
	22	2,	2
	20	2. 17	19
	15	7,5,3,	15
	0	3,	3
		Sum	41

Fourth-

Fourthly thus,

17	24	2, 17	19
	22	2, 17	19
	20	2, 17	19
	15	7, 5, 3,	15
	0	7, 5, 3,	15
		Sum	87

More Ways may be given for the alligating, or linking of the Terms in this Queſtion, but theſe are ſufficient for the Induſtrious, and it ſhall alſo ſuffice to give an Anſwer to the Queſtion as the Terms are link'd the firſt Way, not doubting but the ingenious Practitioner will be able at his Leiſure to find Anſwers to the other 3 Ways, *viz.* oz. p. w. car.

As 56 is to 17, ſo is 28 to 8 —— 10 of 24
As 56 is to 2, ſo is 28 to 1 —— 00 of 22
As 56 is to 19, ſo is 28 to 9 —— 10 of 20
As 56 is to 8, ſo is 28 to 4 —— 00 of 15
As 56 is to 10, ſo is 28 to 5 —— 00 of Alloy.

Thus much well practiſed and underſtood is ſufficient for the underſtanding of Alligation.

The Proof of Alternation Total.

In Queſtions of Alternation Total, the Anſwer given is true, when the Sum of each of the Quantity of Simples found, agrees with the Sum or Quantity propounded, as in the laſt Queſtion, the Anſwer was 8 oz. 10 p. w. of 24 Carects fine, 1 oz. of 22 Carects fine, 9 oz. 10 p. w. of 20 Carects fine, 4 oz. of 15 Carects fine, and 5 oz. of Alloy; which added together make 28 oz. the Quantity propounded.

CHAP. XIX.

Reduction of Vulgar Fractions.

1. WHat a Vulgar Fraction is, and its Parts and ſeveral Kinds hath been already ſhewed in

the 19, 20, 21, 22, 23, 24, and 31 Definitions of the 1st Chapter of this Book, which the Learner is desired diligently to observe before he proceeds.

2. To reduce a Vulgar Fraction (which discovereth the principal Knowledge of Fractions, and therefore ought greatly to be regarded) we shall discover plainly under these Eight several Heads (or Rules) following, *viz.*

1. To reduce a mixt Number into an improper Fraction.

2. To reduce a whole Number into an improper Fraction.

3. To reduce an improper Fraction into its equivalent whole (or mixt) Number.

4. To reduce a Fraction into its lowest Terms equivalent to the Fraction given.

5. To find the Value of a Fraction in the known Parts of Coin, Weight, Measure, *&c.*

6. To reduce a compound Fraction to a simple one of the same Value.

7. To reduce divers Fractions having unequal Denominators, to Fractions of the same Value, having an equal Denominator.

8. To reduce a Fraction of one Denomination to another of the same Value.

I. *To reduce a mixt Number to an improper Fraction.*

The Rule is *Vide Chap.* 1. *defin.* 31.

Multiply the Integral part (or whole Number) by the Denominator of the Fraction, and to the Product add the Numerator, and that Sum place over the Denominator for a new Numerator; so this new Fraction shall be equal to the mixt Number given. As for Example,

1. Reduce $18\frac{3}{7}$ into an improper Fraction, multiply the whole Number 18 by 7 the Denominator, and to the Product add the Numerator 3, the Sum is 129, which put over the Denominator 7, and it makes $\frac{129}{7}$ for the Answer, as followeth

$18\frac{3}{7}$

$$\begin{array}{r} 18\frac{3}{7} \\ 7 \\ \hline 129 \end{array}$$

Facit $\frac{129}{7}$

2. Reduce $183\frac{15}{21}$ to an improper Fraction, *facit* $\frac{3858}{21}$
3. Reduce $36\frac{12}{22}$ to an improper Fraction, *facit* $\frac{804}{22}$

II. *To reduce a whole Number to an improper Fraction.*

The Rule is,

Multiply the given *Number* by the intended *Denominator*, and place the Product for a *Numerator* over it. As for *Example*. *Vide Chapter* 1. *defin.* 23.

1. Let it be required to reduce 15 into a Fraction whose Denominator shall be 12.

To effect which, I multiply 15 by the intended Denominator (12) the Product is 180, which I place over 12 as a Numerator, and it makes $\frac{180}{12}$ which is equal to 15, as was required, as per Margin. *facit* $\frac{180}{12}$

$$\begin{array}{r} 15 \\ 12 \\ \hline 30 \\ 15 \\ \hline 180 \end{array}$$

2. Reduce 36 into an improper Fraction whose Denominator shall be 26, *Facit* $\frac{936}{26}$
3. Reduce 135 into an improper Fraction who Denominator shall be 16, *facit* $\frac{2160}{16}$.

III. *To reduce an improper Fraction into its equivalent whole or mixt Number.*

The Rule is,

Divide the Numerator by the Denominator, and the Quotient is the whole Number equal to the Fraction, and if any Thing remain, put it for a Numerator over the Divisor, Example.

1. Re-

1. Reduce $\frac{436}{8}$ into its equivalent mixt Number, divide the Numerator 436 by the Denominator 8, and the Quotient is 54, and 4 remains, which put for a Numerator over the Divisor 8, the Answer is $54\frac{4}{8}$, as followeth,

8) 436 ($54\frac{4}{8}$

40

36 *facit* $54\frac{4}{8}$

32

4

2. Reduce $\frac{3476}{15}$ to a mixt Number, *facit* $231\frac{11}{15}$.

3. Reduce $\frac{15576}{136}$ to a mixt Number. *facit* $114\frac{72}{136}$.

IV. *To reduce a Fraction into its lowest Terms equivalent to the Fraction given.*

The Rule is,

1. If the Numerator and Denominator are even Numbers, take half of the one, and half of the other as often as may be, and when either of them falls out to be an odd Number, then divide them by any Number that you can discover will divide both Numerator and Denominator without any Remainder; and when you have thus proceeded as low as you can reduce them, then this new Fraction so found out shall be the Fraction you desire, and will be in Value equal to the given Fraction. Example.

1. Let it be required to reduce $\frac{192}{336}$ into its lowest Terms. First, I take the half of the Numerator 192 and it is 96 then half of the Denominator, and it is 168, so that now it is brought to $\frac{96}{168}$, and next to $\frac{48}{84}$, and by halving still to $\frac{24}{42}$ and their half is $\frac{12}{21}$ and now I can no longer halve it, because 21 is an odd Number, wherefore I try to divide them by 3, 4, 5, 6, &c. and I find 3 divides them both without any Remainder, and brings them to $\frac{4}{7}$, as per Margin.

192	96	48	24	12	4
336	168	84	42	21	7

So

So I conclude $\frac{4}{7}$ thus found to be equal in Value to the given Fraction [illegible].

2. What is [illegible] in its lowest Terms? *Answer* [illegible].

3. What is [illegible] in its lowest Terms? *Answer*, [illegible].

There is yet another Way more excellent than the former to reduce a Fraction into its lowest Terms, and that is by finding a common Measurer, *viz.* the greatest Number that will divide the Numerator and Denominator without any Remainder, and by that Means reduce a Fraction to its lowest Terms at the first Work; and to find out this common Measurer divide the Denominator by the Numerator, and if any Thing yet remains, then divide your last Divisor by it; do so until you find nothing remains; then this last Divisor shall be the greatest common Measurer, which will divide both Numerator and Denominator, and reduce them into their lowest Terms at one Work.

Vide Ought *Cla. Math.* Chap. 7.

Example.

4. Reduce $\frac{228}{304}$ into its lowest Terms by a common Measurer. To effect which, I divide the Denominator 304 by the Numerator 228 and there remains 76, then I divide 228 (the first Divisor) by 76 (the Remainder) and it quotes 3, and nothing remains; wherefore the last Divisor 76, is the common Measurer, by which I divide the Numerator of the given Fraction, *viz.* 228, it quotes 3 for a new Numerator; then I divide the Denominator 304 by 76 and quotes 4 for a new Denominator, so that now I have found $\frac{3}{4}$ equal to $\frac{228}{304}$.

5. Reduce [illegible] into its lowest Terms by a common Measurer, *facit* [illegible].

6. Reduce [illegible] into its lowest Terms by a common Measurer, *facit* [illegible].

A Compendium.

Note that if the Numerator and Denominator of a Fraction end each with a Cypher or Cyphers, then cut off as many Cyphers from the one as from the other, and the remaining Figures will be a Fraction of the same Value, *viz.* $\frac{1400}{7700}$ will be found to be reduced to $\frac{14}{77}$ by

by cutting off the Cyphers from the Numerator and Denominator, with a Dash of the Pen thus, $\frac{44|00}{17|00}$, and $\frac{460}{780}$, will be $\frac{46}{78}$, thus, $\frac{46|0}{78|0}$, &c.

V. *To find the Value of a Fraction in the known Parts of Coin Weight, &c.*

The Rule is,

Multiply the Numerator by the Parts of the next inferior Denomination that are equal to an Unit of the same Denomination with the Fraction, then divide that Product by the Denominator, and the Quote gives you its Value in the same Parts you multiplied by, and if any Thing remain multiply it by the Parts of the next inferior Denomination, and divide as before, do so till you can bring it no lower, and the several Quotients will give you the Value of the Fraction as was required, and if any Thing at last remain, place it for a Numerator over the former Denominator; some few Examples will make the Rule plain.

1. What is the Value of $\frac{27}{29}$l. Ster. To answer this Question I multiply the Numerator 27 by 20 (the Shillings in a Pound) the Product is 540, which I divide by 29 (the Denominator) and the Quotient is 18s. and there remains 18, which I multiply by 12 Pence, and the Product (216) I divide by the Denominator 29, the Quotient is 7d. and 13 remains, which I multiply by 4 Farthings, the Product is 52, which I still divide by 29, the Quotient is 1 Farthing, and there remaineth 23, which I put for a Numerator over the Denominator 29, so I find the Value of $\frac{27}{29}$l. to be 18s. 7d. 1 qr. $\frac{23}{29}$, as by the following Operation. and after the same Manner are the Values of the Fractions in the several Examples following found out.

Mul-

$\frac{27}{29}$l.

```
           27
Multiply   20
        ------          qr.
    29) 540 (18s. 7d. 1 23/29
        ..
         29
        ----
         250
         232
        ----
   Rem. (18)
   Mul.  12
        ----
         36
         18
        ----
    29) 216 (7d.
        203
        ----
   Rem. (13)
   Mul.  4
        ----qr.
    29) 52 (1 23/29
        29
        ----
   Rem. (23)
         s.   d.   qr.
Facit   18 — 7 — 1 23/29
```

2. What is the Value of $\frac{11}{15}$l. Sterling? *Facit* 14s. 8d.

3. What is the Value of $\frac{28}{137}$l. Sterling? *Facit* 4s. 1d. $\frac{28}{137}$.

4. What is $\frac{16}{21}$C. Weight? *Facit* 3qrs 1l. 5 oz. $\frac{7}{21}$.

5. What is $\frac{36}{131}$l *Troy* Weight? *Facit* 3 oz. 5 p. w. $22\frac{118}{131}$ gr.

6. What is $\frac{41}{50}$ of a Year? *Answer*, 299 Days, 7 Hours, 12 Minutes.

VI.

VI. *To reduce a compound Fraction to a simple one of the same Value.*

What a compound Fraction is, hath been shewed in Chap. 1. Definition 24, and to reduce it to a simple Fraction of the same Value,

The Rule is,

Multiply the Numerators continually, and place the last Product for a new Numerator, then multiply the Denominators continually, and place the last Product for a new Denominator. So this single Fraction shall be equal to the compound Fraction given. *Example,*

1. Reduce $\frac{2}{3}$ of $\frac{3}{5}$ of $\frac{5}{8}$ to a simple Fraction.

Multiply the Numerators 2, 3, and 5, together, they make 30 for a new Numerator; then I multiply the Denominators 3, 5, and 8 together, and their Product is 120 for a Denominator, so the simple Fraction is $\frac{30}{120}$ and cutting off the Cyphers, it is $\frac{3}{12}$ equal to $\frac{1}{4}$ by the fourth Rule foregoing.

$$\begin{array}{rcr}
5 & \quad & 3 \\
3 & & 2 \\
\hline
15 & & 6 \\
8 & & 5 \\
\hline
120 & & 30
\end{array}$$

Facit $\frac{30}{120}$ or $\frac{3}{12}$ or $\frac{1}{4}$.

2. What is $\frac{7}{10}$ of $\frac{5}{9}$ of $\frac{4}{7}$ of $\frac{11}{12}$? *Answer,* $\frac{1540}{7560}$ or $\frac{154}{756}$ or $\frac{77}{378}$ in its least Terms.

3. What is $\frac{11}{12}$ of $\frac{13}{14}$ of $\frac{21}{23}$? *Answer,* $\frac{3003}{3864}$.

By this you may know how to find the Value of a compound Fraction, *viz.* first reduce it to a simple one, and then find out its Value by the 5th Rule foregoing.

Example

Example,

What is the Value of $\frac{3}{4}$ of $\frac{5}{8}$ of [illegible] of a Pound?
Answer, 11s. 3d.

VII. *To reduce Fractions of unequal Denominators to Fractions of the same Value, having equal Denominators.*

The Rule is,

Multiply all the Denominators together, and the Product shall be the common Denominator. Then multiply each Numerator into all the Denominators except its own, and the last Product put for a Numerator over the Denominator found out as before: So this new Fraction is equal to that Fraction, whose Numerator you multiplied into the said Denominators. Do so by all the Numerators given, and you have your Desire.

Example,

1. Reduce $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{7}{8}$, to one common Denominator. Multiply the Denominators 4, 5, 6, and 8 together continually, and the Product is 960 for the common Denominator; then multiply the Numerator 3 into the Denominators, 5, 6, and 8, and the Product is 720, which is a Numerator to 960 (found as before) so $\frac{720}{960}$ is equal to the first Fraction $\frac{3}{4}$, then I proceed to find a new Numerator to the second Fraction, *viz.* $\frac{4}{5}$ and I multiply 4 (into all the Denominators except its own; *viz.*) into 4, 6, and 8, which produceth $\frac{768}{960}$ equal to $\frac{4}{5}$, then multiply the Numerator 5 into the Denominators 4, 5, and 8, the Product is $\frac{800}{960}$ equal to $\frac{5}{6}$. Then multiply the Numerator 7 into the Denominators 4, 5 and 6, the Product is $\frac{840}{960}$ equal to $\frac{7}{8}$ and the Work is done; so that for $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$, and $\frac{7}{8}$, I have $\frac{720}{960}$, $\frac{768}{960}$, $\frac{800}{960}$, $\frac{840}{960}$.

2. Reduce [illegible] [illegible], and [illegible] into a common Denominator, *Faciunt,* [illegible], [illegible] and [illegible].

VIII.

VIII. *To reduce a Fraction of one Denomination to another.*

1. This is either Aſcending, or Deſcending. Aſcending when a Fraction of a ſmaller is brought to a greater Denomination, and Deſcendſng when a Fraction of a greater Denomination is brought lower.

2. When a Fraction is to be brought from a leſſer to a greater Denomination, then make of it a compound Fraction by comparing it with the intermediate Denominations between it, and that your would have it reduced to, then (by the 6th Rule foregoing) reduce your Compound to a ſimple Fraction, and the Work is done. Example,

Queſt. 1. It is required to know what Part of a Pound Sterling $\frac{4}{7}$ of a Penny is?

To reſolve this, I conſider that 1d. is $\frac{1}{12}$ of a Shilling, and a Shilling is $\frac{1}{20}$ of Pound; wherefore $\frac{4}{7}$d. is $\frac{4}{7}$ of $\frac{1}{12}$ of $\frac{1}{20}$ of a Pound, which by the ſaid 6th Rule I find to be $\frac{4}{1680}$ of a l. Sterling of Engliſh Money.

Queſt. 2. What Part of a Pound Troy Weight is $\frac{4}{5}$ of a Penny Weight? *Anſwer,* $\frac{4}{5}$ of $\frac{1}{20}$ of $\frac{1}{12}$lb. equal to $\frac{4}{1200}$lb. Troy.

3. When a Fraction is to be brought from a greater to a leſſer Denomination, then multiply the Numerator by the Parts contained in the ſeveral Denominations betwixt it, and that you would reduce it to; then place the laſt Product over the Denominator of the given Fraction. Example.

Queſt. 3. I would reduce $\frac{3}{5}$l. to the Fraction of a Penny; to do which I multiply the Numerator 3 by 20 and 12, the Product is 720. which I put over the Denominator 5. is $\frac{720}{5}$ of a Penny, equal to $\frac{3}{5}$l.

Queſt. 4. What Parts of an Ounce Troy Weight is $\frac{3}{80}$l? *Anſwer,* $\frac{36}{80}$ Ounces.

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CHAP. XX.

Addition of Vulgar Fractions.

1. IF your Fractions to be added have a common Denominator, then add all the Numerators together, and place their Sum for a Numerator to the common Denominator, which new Fraction is the Sum of all the given Fractions; and if it be improper, reduce it to a whole or mixt Number, by the 3d Rule of the 19th Chapter.

Quest. 1. What is the Sum of $\frac{7}{24}$, $\frac{9}{24}$, $\frac{16}{24}$ and $\frac{14}{24}$?

The Denominations are equal, *viz.* every one is 24, wherefore add the Numerators together, *viz.* 7, 9, 16, and 14, their Sum is 46, which put over the Denominator 24; it makes $\frac{46}{24}$ the Sum of the given Fractions, which will be reduced to the mixt Number $1\frac{22}{24}$ or $1\frac{11}{12}$.

2. But if the Fractions to be added have unequal Denominators, then reduce them to a common Denominator by the 7th Rule of the 19th Chapter, and then add the Numerators together, and put the Sum over the common Denominator, *&c.* as before in the last Example.

Quest. 2. What is the Sum of $\frac{3}{5}$; $\frac{7}{8}$, $\frac{9}{10}$, and $\frac{11}{12}$?

The Fractions reduced to a common Denominator are $\frac{2880}{4800}$, $\frac{4200}{4800}$, $\frac{4320}{4800}$, and $\frac{4400}{4800}$, the Sum of their Numerators is 15800 which put over the common Denominator, makes $\frac{15800}{4800}$ or $\frac{158}{48}$ equal to the mixt Number $3\frac{14}{48}$, or $3\frac{7}{24}$ for the Sum required.

Quest. 3. What is the Sum of $\frac{12}{19}$, $\frac{21}{43}$, and $\frac{26}{43}$? *Answer.* $1\frac{27555}{35131}$.

3. If you are to add mixt Numbers together, then add the Fractional Parts as before, and if their Sum be an improper Fraction reduce it to a mixt Number and add its integral Part to the integral Parts of the given mixt Numbers, and the Work is done.

Quest. 4. What is the Sum of $13\frac{3}{4}$ and $24\frac{5}{6}$?

First add the Fractions $\frac{3}{4}$ and $\frac{5}{6}$ the Sum is $1\frac{7}{12}$ then add

add this Integer 1, to 13 and 24, their Sum is 38, and put after it the Fraction $\frac{12}{32}$ it is $38\frac{12}{32}$ for the *Answer*, or it is $38\frac{3}{8}$.

Quest. What is the Sum of $48\frac{3}{7}$, $64\frac{5}{8}$ and $130\frac{3}{4}$? *Facit* $243\frac{180}{224}$, or $243\frac{45}{56}$.

4. If any of the Fractions to be added is a compound Fraction, it must first be reduced to a simple Fraction by the 6th Rule of Chapter 19, and then add it to the rest, according to the 2d Rule of this Chapter. Example,

Quest. 6. What is the Sum of $\frac{3}{4}$, $\frac{5}{6}$, and $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$? Reduce $\frac{7}{8}$ of $\frac{3}{4}$ of $\frac{5}{6}$ into a simple Fraction, and it is $\frac{105}{192}$, which reduced with the other two, and added are $2\frac{600}{768}$.

Quest. 7. What is the Sum of $\frac{11}{12}$ and $\frac{3}{4}$ of $\frac{4}{5}$ of $\frac{5}{6}$? *Answer*, $1\frac{5}{12}$.

5. If the Fraction to be added are not of one Denomination, they must be so reduced, and then proceed as before.

Quest. 8. What is the Sum of $\frac{3}{4}$l. and $\frac{5}{6}$s.

Of the given Fractions here; one is of a Pound and the other the Fraction of a Shilling; and before you can add them together, you must reduce $\frac{5}{6}$s. to the Fractiou of a Pound as the other is (by the 8th Rule of Chapter 19) and it makes $\frac{5}{120}$l. then $\frac{3}{4}$l. and $\frac{5}{120}$l. will be found to be $\frac{380}{480}$l. or $\frac{38}{48}$l. by the 7th Rule of Chapter 19, and in its lowest Terms $\frac{19}{24}$l. by the 4th Rule of Chapter 19.

It would have been the same, if (by the latter Part of the 8th Rule of Chapter 19) you had reduced $\frac{3}{4}$l. to the Fraction of a Shilling, which you would have found to have been $\frac{60}{4}$s. which added to $\frac{5}{6}$s. by the said 17th Rule of the last Chapter, the Sum is 15s. $\frac{20}{24}$, which is equal to the Sum found as before, *viz.* $\frac{19}{24}$l. for (by the 5th Rule of Chapter 19) the Value of $\frac{19}{24}$l. will be found to be 15s. 10d. and so will 15s. $\frac{20}{24}$ be found to be just as much.

Quest.

Quest. 9. What is the Sum of $\frac{2}{3}$l. $\frac{3}{5}$s. and $\frac{3}{4}$d. *Answer*, $\frac{355500}{480000}$ or $\frac{3555}{4800}$l. or in its lowest Terms $\frac{1185}{1600}$l.

CHAP. XXI.

Subtraction of Vulgar Fractions.

1. THE Rules in Addition for reducing the given Fractions to one Denomination, are here to be observed; for before Subtraction can be made, the Fractions must be reduced to a common Denominator, then subtract one Numerator from the other, and place the Remainder over the common Denominator, which Fraction shall be the Excess or Difference between the given Fractions. Example.

Quest. 1. What is the Difference between $\frac{3}{4}$ and $\frac{5}{7}$? The given Fractions are reduced to $\frac{21}{28}$ and $\frac{20}{28}$, then subtract the Numerator 20 from the Numerator 21, and there remains 1, which being put over the Denominator 28, makes $\frac{1}{28}$ for the Answer or Difference between $\frac{3}{4}$ and $\frac{5}{7}$.

Quest. 2. What is the Difference between $\frac{5}{6}$ and $\frac{3}{5}$ of $\frac{5}{8}$?

Reduce the compound Fraction $\frac{3}{5}$ of $\frac{5}{8}$ to a simple Fraction, then proceed as before, and the Answer is $\frac{110}{240}$ equal to $\frac{11}{24}$.

2. When a Fraction is given to be subtracted from a whole Number, subtract the Numerator from the Denominator, and put the Remainder for a Numerator to the given Denominator, and subtract an Unit (for that you borrowed) from the whole Number, and the Remainder place before the Fraction found, as before, which mixt Number is the Remainder or Difference sought. Example. *Quest.* 3. Subtract $\frac{7}{10}$ from 48.

Answer, $47\frac{3}{10}$; for if you subtract 7 (the Numerator) from 10 (the Denominator) there remains 3, which put over 10 is $\frac{3}{10}$ and 1 (I borrowed) from 48 rests 47, to which join $\frac{3}{10}$ and it makes $47\frac{3}{10}$ for the Excess.

Quest. 4. Subtract $\frac{13}{21}$ from 57 remains $56\frac{8}{21}$.

3. If it is required to ſubtract a Fraction from a mixt Number, or one mixt Number from another, reduce the Fractions to a common Denominator, and if the Fraction to be ſubtracted be leſſer than the other, then ſubtract the leſſer Numerator from the greater, and that is a Numerator for the common Denominator; then ſubtract the leſſer integral Part from the greater, and the Remainder with the remaining Fraction thereto annexed, is the Difference required between the two given mixt Numbers. Example,

Queſt. 5. Subtract $26\frac{3}{7}$ from $54\frac{5}{8}$.

Firſt, Subtract $\frac{3}{7}$, *viz.* $\frac{24}{56}$ from $\frac{5}{8}$, *viz.* $\frac{35}{56}$, the Remainder is $\frac{11}{56}$ then 26 from 54 remaineth 28, to which annex $\frac{11}{56}$, it makes $28\frac{11}{56}$ for the *Anſwer.*

4. But if the Fraction to be ſubtracted is greater than the Fraction from whence you ſubtract, then having firſt reduced the Fraction to a common Denominator, take the Numerator of the greater Fraction out of the Denominator, and add the Remainder to the Numerator of the leſſer Fraction, and their Sum is a new Numerator to the common Denominator, which Fraction note, then, (for the 1 you borrowed) add 1 to the integral Part to be ſubtracted. and ſubtract it from the greater Number, and to the Remainder annex the Fraction you noted before, ſo this new mixt Number ſhall be the Difference ſought. Example,

Queſt. 6. Subtract $14\frac{3}{4}$ from $29\frac{4}{7}$.

The Fractions reduced are, equal to $\frac{21}{28}$, and $\frac{4}{7}$ equal to $\frac{16}{28}$, now I ſhould ſubtract $\frac{21}{28}$. from $\frac{16}{28}$, but I cannot, therefore I ſubtract 21 from 28 reſts 7, which added to 16 (the leſſer Numerator) make 23 for a Numerator to 28; *viz.* $\frac{23}{28}$, then I come to the integral Parts 14 and 29, and ſay, 1 that I borrowed and 14, is 15, which taken from 29 there reſts 14, to which annexing $\frac{23}{28}$ it is $14\frac{23}{28}$ for the Remainder or Difference between $14\frac{3}{4}$ and $29\frac{4}{7}$.

Queſt. 7. Subtract $36\frac{7}{18}$ from $74\frac{2}{3}$, *Facit* $37\frac{5}{18}$.

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half of the remaining Figures (after the first is cut off) and set them under the Line, and they are so many Pounds, but if the last Figure is odd, then take the lesser half, and add ten to the Figure so cut off (as before) for Shillings, as if I were to reduce 43658 Shillings into Pounds, first I cut off the last Figure (8) for Shillings then I take half of the remaining Figures (4365) thus half of 4 is 2, which I put under the Line, then $\frac{1}{2}$ of 3 is 1, and because 3 is an odd Number, I make the next Figure 6 to be 16, and I go on, saying, $\frac{1}{2}$ of 16 is 8, and then $\frac{1}{2}$ of 5 is 2, which is the last Figure, wherefore because 5 is an odd Number, I add 10 to the 8 I cut off, and it makes 18s. so that I find it to be 2182l. 18s, as per Margin.

4365|8

l.	s.
2182	18

4. It is likewise convenient that the Learner be acquainted with the practical Tables following, the first containing the Aliquot (or even) Parts of a Shilling, the second containing the Aliquot Parts of a Pound.

The even Parts of a Shilling.	d.	is	s.
	6		$\frac{1}{2}$
	4		$\frac{1}{3}$
	3		$\frac{1}{4}$
	2		$\frac{1}{6}$
	$1\frac{1}{2}$		$\frac{1}{8}$
	1		$\frac{1}{12}$

The even Parts of a Pound.	s.	d.	is	l.
	10	0		$\frac{1}{2}$
	6	8		$\frac{1}{3}$
	5	0		$\frac{1}{4}$
	4	0		$\frac{1}{5}$
	3	4		$\frac{1}{6}$
	2	6		$\frac{1}{8}$
	2	0		$\frac{1}{10}$
	1	8		$\frac{1}{12}$
	1	0		$\frac{1}{20}$

CASE

CASE, I.

5. When the Price of the Integer is a Farthing, then take the ſixth Part of the given Number, which will be ſo many Three-halſ-pences, and if any Thing remains it is Farthings, by the 7th Rule of Chap. 9. then conſider that Three half-pence is $\frac{1}{8}$ of a Shilling, wherefore take the 8th Part of them for Shillings, and if any Thing remain they are ſo many Three-halfpence, which reduce into Pounds, by the 3d Rule foregoing. Example, What comes 67486l. to, at a Farthing per l. First, I take $\frac{1}{6}$ of 67486 and it is 11247 Three-halfpence and 4 Farthings, or one Penny; then $\frac{1}{8}$ of 11547 is 1405s. and 7 remains, which is 7 Three-halfpence, or $10\frac{1}{2}$d. which with the 4 Farthings before make $11\frac{1}{2}$ d. and 1405 Shilling, which by the 3d Rule is 70l. 5s. In all 70l. 5s. $11\frac{1}{2}$d. for the Anſwer. See the Work following.

$\frac{1}{6}$	67486 at $\frac{1}{4}$ per l.
	d.
$\frac{1}{8}$	11247—1
$\frac{1}{20}$	140|5—$10\frac{1}{2}$
	l. s. d.
	70. 5. $11\frac{1}{2}$ *Facit*

Other Examples follow.

$\frac{1}{6}$	85761 at 1 qr.
$\frac{1}{8}$	1429——2 qrs.
$\frac{1}{20}$	17|8——8d.
	l. s. d.
	8—18—$8\frac{1}{2}$

$\frac{1}{6}$	6380l. at 1 qr.
$\frac{1}{8}$	1063——2 qrs.
$\frac{1}{20}$	13|2——11d.
	l. s. d.
	6—12—$11\frac{1}{2}$

When

6. When the Price of the Integer is 2 Farthings, then take the third Part of the given Number for so many Three-half-pences, and the Remainder (if any) is Half-pence, then take the eighth Part of that for Shillings, as before, *&c.*

Examples.

$\frac{1}{3}$	7368l. at 2 qrs.		$\frac{1}{3}$	8347l. at 2 qrs.
$\frac{1}{8}$	2456		$\frac{1}{8}$	2782——2 qrs.
$\frac{1}{20}$	30|7		$\frac{1}{20}$	34|7——9d. $\frac{1}{2}$.
	l. s.			l. s. d.
	15——7 *facit*			17—7—9$\frac{1}{2}$ *facit*

7. When the Price of the Integer is 3 Farthings, then take Half the given Number for Three-half-pence, (and if any Thing remain it is 3 Farthings) then take the Eighth of that for Shillings, as before, *&c.*

$\frac{1}{2}$	4736l. at 3 qrs.		$\frac{1}{2}$	5425l. at 3qrs.
$\frac{1}{8}$	2368		$\frac{1}{8}$	2712——3qrs.
$\frac{1}{20}$	29|16		$\frac{1}{20}$	33|9
	l. s.			l. s. d. qrs. *fa.*
	14——16 *facit.*			16—19—0—3

CASE 2.

8. When the given Price of the Integer, is a Part, or Parts of a Shilling, *viz.* Pence divide the given Number of Integers (whose Value is sought) by the Denominator, or the Fraction representing the even Part, and the Quote is Shillings (always minding the 7th Rule of the 9th Chap.) and those Shillings may be reduced into Pounds by the 3d Rule of this Chap. Example, Let it be required to find the Value 438l. at 3d. per

per Pound, I consider 3d. is $\frac{1}{4}$ of a Shilling, and 438l. will cost so many 3 Pences, wherefore I divide 438l. by 4, the Denominator of $\frac{1}{4}$, and the Quote is 109 Shillings, and 2 remains, which is 2 Three-pences or 6d. the whole Value is 5l. 9s. 6d. as by the following Work appeareth.

$\frac{1}{4}$	438l. at 3d.
$\frac{1}{20}$	10|9——6
	l. s. d
facit	5—9—6

More Examples follow.

	l. d.
$\frac{1}{2}$	3574 at 6 per l.
$\frac{1}{20}$	178|7
facit	89l. 7 s.

	l. d.
$\frac{1}{6}$	5316 at 2 per l.
$\frac{1}{20}$	88|6
facit	44l. 6s.

	l. d.
$\frac{1}{3}$	438 at 4 per l.
$\frac{1}{20}$	14|6
facit	7l. 6s.

	l. d.
$\frac{1}{8}$	6389 at $1\frac{1}{2}$ per l.
$\frac{1}{20}$	79|8——7d. $\frac{1}{2}$
facit	39l. 18s. 7d. $\frac{1}{2}$.

	l. d.
$\frac{1}{4}$	879 at 3 per l.
$\frac{1}{20}$	219——9d.
facit	10l. 19s. 9d.

	l. d.
$\frac{1}{12}$	818 at 1 per l.
$\frac{1}{20}$	6|8——2
facit	3l. 8s. 2d.

9. If the Price of the Integer be Pence under 12, and yet not an even Part, then it may be divided into even Parts and so the Parts of the given Number taken accordingly, and added together, as if it were 5d. which

which is 3d. and 2d. *viz.* $\frac{1}{4}$ and $\frac{1}{6}$ of a Shilling, first take $\frac{1}{4}$ of the given Number, and then $\frac{2}{3}$ thereof, and add them together, and their Sum is the Anſwer in Shillings, ſtill obſerving Rule 7. of Chap. 9. for the Remainders, if any be, then bring the Shillings into Pounds by the 3d Rule foregoing. Likewiſe 7d. is $\frac{1}{2}$ and $\frac{1}{6}$, ſo 9d. is $\frac{1}{2}$ and $\frac{1}{4}$, and 10d. is $\frac{1}{2}$ and $\frac{1}{3}$, and 11d. is $\frac{1}{2}$ and $\frac{1}{3}$ and $\frac{1}{4}$ of a Shilling, or elſe many times your Work may be ſhortned thus, *viz.* when the ſaid given Price is to be divided into even Parts of a Shilling or of a Pound, after you have taken the firſt even Part, the other may be an even Part of that Part, as in the next Example, where is given 439l. at 5d. per l. now I may divide it thus *viz.* into 4d. and 1d. for 4d. being $\frac{1}{3}$ of a Shilling, and 1d. being $\frac{1}{4}$ of 4d. I firſt take $\frac{1}{3}$ of 439l. and it gives 146s. 4d. and for the 1d. I take $\frac{1}{4}$ of 146s. 4d. which is 36s. 7d. which in all comes to 9l. 2s. 11d. Examples follow.

	l.	d.
	439 at	5 per l.
$\frac{1}{3}$	146 —	4
$\frac{1}{4}$	36 —	7
	18|2 —	11
	9l. 2s. 11d. *facit.*	

	yds.	d.
	417 at	9
$\frac{1}{2}$	208 —	6
$\frac{1}{2}$	104 —	3
	31|2 —	9
	15l. 12s. 9d. *facit.*	

	ells	d.
	587 at	7 per ell.
$\frac{1}{3}$	195 —	8
$\frac{1}{4}$	146 —	9
	34|2 —	5
	17l. 2s. 5d. *facit.*	

	ells.	d.
	386 at	10
$\frac{1}{2}$	193	
$\frac{1}{3}$	128 —	8
	32|1 —	8
	16l. 1s. 8d. *facit.*	

	yds. d.		l. d.
	836 at 8 per yd.		534 at 11
$\frac{1}{3}$	278—8	$\frac{1}{3}$	178
$\frac{1}{3}$	278—8	$\frac{1}{3}$	178
	55|7—4	$\frac{1}{4}$	133—6
	27l. 17s. 4d. *facit*		48|9—6
			24l. 9s. 6d. *facit.*

CASE, 3.

10. When the Price of the Integer is Pence and Farthings, if it make an even Part of a Shilling, work as before, but if they are uneven, as Penny Farthing, Penny three Farthings, 2d. 1qr. or 2d. 3qrs. 3d. 3qrs. or the like, then first work for some even Part, and then consider what Part the rest is of that even Part, and divide that Quotient thereby, then add them together, and reduce them to Pounds as before. Example. 3470l. at 1d. 1qr. per l. first I work for the Penny by dividing 3470 by 12, for 1d. is $\frac{1}{12}$ of a Shilling, and the Quote is 289s. 2d. then I conceive that one Farthing is the $\frac{1}{4}$ of a Penny, and the Value at one Farthing, will be $\frac{1}{4}$ of the Value at 1 Penny, and therefore I take $\frac{1}{4}$ of 289s. 2d. which is 72s. 3d. 2qrs. and add them together, and they are 18l. 1s. 5d. 2qrs. as by the Margin. Other Examples of the same Nature follow.

	l. qrs.
$\frac{1}{12}$	3470 at 5
$\frac{1}{4}$	289—2
	72—3—2
$\frac{1}{20}$	36|2—5—2
	l. s. d.
	18—1—5$\frac{1}{2}$

	l. d.		yds. d.
$\frac{1}{2}$	4360 at $1\frac{1}{4}$	$\frac{1}{8}$	573 at $1\frac{1}{2}$
$\frac{1}{4}$	363—4	$\frac{1}{8}$	71—$7\frac{1}{2}$d.
	90—10		11—$11\frac{1}{4}$
	45|4—2		8|3—$6\frac{3}{4}$
	l. s. d.		l. s. d.
	22—14—2 *facit*		*facit* 4—3—$6\frac{3}{4}$
$\frac{1}{6}$	485l. at $2\frac{1}{4}$d.	$\frac{1}{2}$	520 yds. at $7\frac{1}{2}$
$\frac{1}{8}$	80—10d.	$\frac{1}{4}$	260
	10— $1\frac{1}{4}$		65
	9|0—$11\frac{1}{4}$	$\frac{1}{20}$	32|5
	4l. 10s. $11\frac{1}{4}$d.		16l. 5s. *facit*
$\frac{1}{6}$	654l. at $2\frac{1}{2}$d.	$\frac{1}{2}$	137 yds. at 10d$\frac{1}{2}$d.
$\frac{1}{4}$	109	$\frac{1}{2}$	68—6d.
	27—3d.	$\frac{1}{2}$	34—3
			17—$1\frac{1}{2}$
	13|6—3	$\frac{1}{20}$	11|9—$10\frac{1}{2}$d.
	6l. 16s. 3d.		5l. 19s. $10\frac{1}{2}$d *facit*

CASE, 4.

14. When the Price of the Integer is 2s. then cut off the Figure in the Place of Units of the given Number, and double it for Shillings, and the Figures on the other Hand are Pounds, Example, 436 yds. at 2s. per yd. cut off the last Figure, 6 and double it, it makes 12 Shillings, and the other 2 Figures, *viz.* 43, are so many Pounds, so that their Value is 43l. 12s. as per Margin.

43|6
43l. 12s

12. Hence

12. Hence it is evident that when the given Price of an Integer is an even Number of Shillings, then if you take half of that even Number of Shillings, and multiply the given Number of Integers thereby doubling the first Figure of the Product and setting it a-part for Shillings, the rest of the Product will be Pounds, which Pounds and Shillings is the Value sought. Example. What cost 536 Yards at 8s. per Yard? To resolve which, I take ½ of 8s. (the Price of a yd.) which is 4, and multiply 536 thereby, saying, 4 times 6 is 24, then I double the first Figure 4, makes 8 for Shillings, and carry 2 to the next Product, &c. I find the rest of the Product to be 214, which I note for Pounds, so the Value of 536 yds. at 8s. per yd. is 214l. 8s. as per Margin. More Examples follow.

536 yds. at 8s.	
4	
214l. 8s.	

56 yds at 6s. per yd.	420 yds. at 12s. per yd.
16l. 16s. *facit.*	252l. *facit.*
123 yds at 4s. per yd.	326 yds at 14s. per yd.
24l. 12s. *facit.*	228l. 4s. *facit.*
48 ells at 8s. per ell.	48 yds. at 16s. per yd.
19l. 4s. *facit.*	38l. 8s. *facit.*
84 yds. 10s. per yd.	52 yds. at 18s. per yd.
42l. *facit.*	46l. 16s. *facit.*

13. If the given Price of the Integer is an odd Number of Shillings, then work first for the even Number of Shillings by the last Rule, and for the odd Shilling take $\frac{1}{20}$ of the given Number of the Integers according to the 3d Rule of this Chapter, and add them together, and you have your Desire. Examples follow.

yds.

yds.	s.
422 at	3 per yd.
l.	s
42	4
21	2
63	6 *facit.*

ells.	s.
431 at	13
l.	s.
258	12
21	11
280	03 *facit.*

ells.	s.
516 at	7 per ell.
l.	s.
154	16
25	16
180	12 *facit.*

ells.	s.
324 at	17 per ell.
l.	s.
259	04
16	04
275	08 *facit.*

14. Except when the given Price of the Integer is 5s. for then it is sooner answered by taking $\frac{1}{4}$ of the given Number whose Value is sought, as in the following Example.

	yds. s.
$\frac{1}{4}$	436 at 5 per yd.
	109l. *facit.*

	ells. s.
$\frac{1}{4}$	206 at 5 per ell.
	51l. 10s. *facit.*

CASE. 5.

15. When the given Price of an Integer is Shillings and Pence, or Shillings, Pence and Farthings; then if the Shillings and Pence be an even Part of a Pound; divide the given Number of Integers, whose Value you seek by the Denominator of that Fraction representing that even Part. As for Example, what is the Price of 384 Yards at 6s. 8d. per Yard? Here I consider that 6s. 8d. is $\frac{1}{3}$ of a Pound, wherefore I divide 384 by 3, and the Quote is the Answer, viz. 128l. so that 384 yds. at 6s. 8d. per yd. amounts to 128l. as per Margin, still observing the 7th Rule of the 9th Chapter.

$\frac{1}{3}$	384
	128l. *facit.*

More

More Examples follow.

$\frac{1}{3}$	438 ells at 6s. 8d.		$\frac{1}{8}$	443 yds. at 2s. 6d.
	146l. *facit.*			55l. 7s. 6d. *facit.*
$\frac{1}{6}$	525 at 3s. 4d.		$\frac{1}{12}$	726 yds. at 1s. 8d.
	87l. 10s. *facit.*			60l. 10s. *facit.*

16. When the given Value of the Integer is Shillings and Pence, and not an even part of a Pound, yet many Times it may be divided into Parts (*viz.* 6s. 6d. is 4s. and 2s. 6d. for the 4s. work according to the 12th Rule foregoing, and for the 2s. 6d. take the Eighth Part of the given Number and add them together then their Sum is the Value required.)

So 8s. 6d. will be divided into 6s. and 2s. 6d. and the Price of the given Number may be found out as before, &c.

	yds.	s.	d.		ells	s.	d.
	386 at	8	8		540 at	5	4
$\frac{1}{3}$	128l.	13	4	$\frac{1}{10}$	54l.	0	
$\frac{1}{10}$	38l.	12	0	$\frac{1}{6}$	90l.	0	
	167l. 5s. 4d. *facit.*				144l. *facit.*		
	ells.	s.	d.		yds.	s.	d.
s.	427 at	8	6		386 at	14	8
6	128l.	2	0	s.		4	
$\frac{1}{4}$	53l.	7	6	8	154l.	8	0
	181l. 9s. 6d. *facit.*			$\frac{1}{3}$	128l.	13	4
					283l. 1s. 4d. *facit.*		

17. When the given Price of the Integer is Shillings and Pence, and you cannot readily divide them according to the last Rule, then multiply the given Number whose Value you seek by the Number of Shillings in the Price of the Integer, and then for the Pence work by the 8th Rule foregoing, then add the Numbers together,

ther, and their Sum is the Value sought in Shillings; as for Example, what is the Value of 392 yds at 6*s.* 9*d.* per yd.? Here 6*s.* 9*d.* cannot be made any even Part nor indeed can it be divided into even Parts of a Pound, wherefore I multiply the given Number of Yards 392 by 6, for the 6*s*, the Product is 2352*s.* then for the 9*d.* I divide it into 6*d.* and 3*d.* and work for them by the 8th Rule foregoing, and at last add the Shillings together, they make 2646*s.* and by the 3d Rule they are reduced to 132*l.* 6*s.* the Value of 392 yards at 6*s.* 9*d.* per Yard. See the Work following.

```
        | yds.     s.    d.
        | 392 at 6——— 9
        |------------------
        | 2352
d. | ½  |  196
6  | ½  |   98
4  |    |------------------
        | 264|6
   | 20 |------------------
        | 132l. 6s. facit.
```

Other Examples follow.

```
s. | l.      s.    d.           |    ells    s.    d.
⅓  | 480 at 4——— 10             |    732 at 12——— 7
s. |   4                        |     12
   |--------------------        |    --------------------
d 4| 1920                       | 12 | 8784
6 ½|  240                       | 4 ⅓|  244
4 ⅓|  160                       | 3 ¼|  183
   |--------------------        |    --------------------
   | 232|0                      |    | 921|1
   |--------------------        |    --------------------
   | 116l. facit.               |    4  60l. 11s. facit.
```

18. When the given Price of the Integer is Shillings Pence and Farthings, then multiply the given Number of Integers by the Number of Shillings contained in the Value of the Integer, and for the Pence and Farthings follow the 10th Rule of this Chapter.

Example.

EXAMPLES.

yds. s. d.
438 at 8——$6\frac{3}{4}$
8
d | 3504
6 | $\frac{1}{2}$ | 219
$\frac{3}{4}$ | $\frac{1}{8}$ | 27——$4\frac{1}{2}$d.
375|0——$4\frac{1}{2}$d.
187l. 10s. $4\frac{1}{2}$d. *facit.*

ells s. d.
370 at 14——$2\frac{3}{4}$
14
1480
370
d | 5180 d.
2 | $\frac{1}{6}$ | 61——8
$\frac{1}{2}$ | $\frac{1}{4}$ | 15——5
$\frac{1}{4}$ | $\frac{1}{2}$ | 7——$8\frac{1}{2}$
5264|4——$9\frac{1}{2}$
263l. 4s. 9d. $\frac{1}{2}$. *facit.*

ells s. d.
136 at 9——$2\frac{1}{2}$
9
d | 1224——0
2 | $\frac{1}{6}$ | 22——8
$\frac{1}{2}$ | $\frac{1}{4}$ | 5——8
125|2——4
62l. 12s. 4d. *facit.*

ells s. d.
431 at 2——$4\frac{1}{2}$
2
d | 862
3 | $\frac{1}{4}$ | 107——9d
$1\frac{1}{2}$ | $\frac{1}{2}$ | 53——$10\frac{1}{2}$
102|3——$7\frac{1}{2}$
51l. 3s. $7\frac{1}{2}$d. *facit.*

CASE, 6.

19. When the given Value of the Integer is Pounds then multiply the Number of Integers whose Value is sought by the Price of the Integer, and the Product is the Answer in Pounds.

EXAMPLES.

C. l.
42 at 2 per C.
84l. *facit.*

C. l.
13 at 8 per C.
104l. *facit.*

30

C.	l.		C.	l.
30 at	3 per C.		48 at	12
90l. *facit.*			576l. *facit.*	

CASE, 7.

20. If the Price of the Integer is Pounds and Shillings, then for the Pounds, work as in the last Rule; and for the Shillings as in the 12 and 13 Rules beforegoing; then add the Numbers produced from them both, and the Sum is the Value sought.

EXAMPLES.

	C.	l.	s.
	46 at	2——	4.
2l.	92	s.	
s. 4 $\frac{1}{5}$	9——	4	
	101l. 4s. *facit.*		

	gross	l.	s.
	58 at	3——	7
3l.	174	s.	
6s.	17——	8	
1s.	2——	18	
	294l. 6s. *facit.*		

	gross	l.	s.
	82 at	4——	10
4l.	328		
10s $\frac{1}{2}$	41		
	369l. *facit.*		

	gross	l.	s.
	26 at	3——	15
3l.	78		
14s.	18——	4	
1s.	1——	6	
	97l. 10s. *facit*		

21. When the given Price of an Integer consists of Pounds, Shillings, and Pence, with Farthings, then work for the Shillings, Pence, and Farthings according to the 18th Rule of this Chapter, and find the Total Value of the given Number, as if there were no Pounds, then work with the Pounds according to the 19th Rule of this Chapter, and add the Numbers thus found, and their Sum is the Total Value required.

EX-

EXAMPLES, of this RULE follow.

C. l. s. d.
213 at 1—13—4½.
639
213
13s. | 2769 d.
3d ¼ | 53—3
1½d ½ | 26—7½
2841|8—10½d.
142l. 08s. 10½d.
1l. | 213
355l. 8s. 10½d. *facit.*

C. l. s. d.
37 at 3—8—10½
296 d. | 8s.
18—6 | 6d. ½
9—3 | 3d. ½
4—7½ | 1½d. ½
32|8—4½d.
16l. 8s. 4½d.
111 | 3l.
127l. 8s. 4½d. *facit*

gross l. s. d.
9s. | 416 at 2—9—3¾
3d ¼ | 3744
¾d ¼ | 104
26
387|4
193l. 14s.
2l. | 832
1025l. 14s. *facit.*

gross l. s. d.
48 at 3—15—10½
240
48
720 | 15s.
24 | 6d. ½
16 | 3d. ¼
6 | 1½d ⅛
76|6
38—6
144 | 3l.
182l. 6s.

22. When there is given the Value of an Integer, and it is required to know the Value of many such Integers together, with ¼ or ½ or ¾ of an Integer, then first (by the former Rules) find out the Value of the given Number of Integers, and then for ¼ of an Integer take ¼ of the given Value of the Integer, or for ½ take ½ of the given Value of the Integer, and for ¾ first

$\frac{1}{4}$ first take $\frac{1}{2}$ of the given Value, and then $\frac{1}{2}$ of that $\frac{1}{2}$, setting each Part under the preceding, then adding them together, their Sum will be the required Value of the Integers and their Parts. Example; what is the Value of 116$\frac{1}{2}$ Yards at 4s. 6d. per Yard? To give an Answer, first, I work for the Value of 116 Yards by the 15th Rule foregoing, and then for the $\frac{1}{2}$ Yard, I take $\frac{1}{2}$ of 4s 6d. which is 2s. 3d. and add to the rest found as before, then is that Sum the total Value of 116$\frac{1}{2}$ Yards, at 4s. 6d. per Yard, which I find to amount to 26l. 4s. 3d. as by the Work in the Margin.

yards s. d.
116$\frac{1}{2}$ at 4—6

11l. 12s	2s. $\frac{1}{10}$
14—10s.	2s. 6d $\frac{1}{8}$
2-3	$\frac{1}{2}$ *yard.*

26—4—3 *Facit*

Other Examples follow.

324$\frac{1}{4}$ *yds.* at 4s. 10d.

1296	4s.
162	6d. $\frac{1}{2}$
108	4d. $\frac{1}{3}$
1—2$\frac{1}{2}$d.	$\frac{1}{4}$ *yd.*

156|7s 2$\frac{1}{2}$d.

78l. 7s 2$\frac{1}{2}$d. *facit.*

228 $\frac{3}{4}$ ells at 12s. 11d.

2736	12s.
76	4d. $\frac{1}{3}$
76	4d. $\frac{1}{3}$
57	3d. $\frac{1}{4}$
6—5 $\frac{1}{2}$d.	$\frac{1}{2}$ ell.
3—2 $\frac{3}{4}$d.	$\frac{1}{4}$ ell.

295|4—8$\frac{1}{4}$d.

147l. 14s. 8 $\frac{1}{4}$d. *facit.*

720$\frac{1}{2}$ *yds.* at 6s. 8d.

240l. 3s. 4d. *facit.*

C. qrs. l. l. s. C.
28—3—14 at 1—10

28l.	1l.
14l.	10s. $\frac{1}{2}$
15s.	$\frac{1}{2}$C.
7s. 6d.	$\frac{1}{4}$C.
3s. 9d.	14l.

43l. 6s. 3d. *facit.*

Many more Questions may be stated, and several other Rules of Practice may be shewn according to the Method of divers Authors, but what hath been delivered here are sufficient for the practical Arithmetician in all Cases whatsoever.

CHAP. XXVII.

The Rule of Barter.

1. BARTER is a Rule amongst Merchants, which (in the exchanging of one Commodity for another) informs them so to Proportion their Rates as that neither may sustain Loss.

2. To resolve Questions in Barter, it will not be difficult to him that is acquainted with the Golden-Rule, or Rule of Three, it being altogether used in resolving such Questions.

Quest. 1. Two Merchants, (*viz.* A and B) Barter. A hath 13 C. 3 qrs. 14l. of Pepper at 2l. 16s. per C. and B hath Cotton at 9d. per l. I demand how much Cotton B must give A for his Pepper? *Answer*, 9 C. 1 qr.

First, find by the Rule of Three, or the Rules of Practice foregoing, how much the Pepper is worth, saying. If 1 C. cost 2l. 16s. what will 13 C. 3 qrs. 14l. cost? *Answer*, 38l. 17s.

Secondly, By the Rule of Three, say, If 9d. buy 1l. of Cotton, how much will 38l. 17s. buy?

Answer, $9\frac{1}{4}$C. and so much Cotton must B give to A for 13 C. 3 qrs. 14l. of Pepper at 2l. 16s. per C. when the Cotton is worth 9d. per Pound.

Quest. 2. Two Merchants (A and B) Barter, A hath Ginger worth 1l. 17s. 4d. per C. but in Barter he will have 2l. 16s. per C. B hath Nutmegs worth 5l. 12s per C. now I demand how B must rate his Nutmegs per C. to make his Gain in Barter equal to that of A?

Answer, 8l. 8s.

Say, By the Rule of 3, If 1l. 17s. 4d. require 2l. 16s.

in

in Barter, what will 5l. 12s. require in Barter?

Facit, 8l. 8s.

Quest. 3. A and B Barter, A hath 120 Yards of Broad-Cloth, worth 6s. per Yard, but in Barter he will have 8s. per Yard, B hath Shalloon worth 4s. per Yard. Now I demand how many Yards of Shalloon B must give A for his Broad-Cloth, making his Gain in Barter equal to that of A?

Answer, 180 Yards of Shalloon.

First, (as in the last Question) find out how B ought to sell his Shalloon in Barter, *viz.* say, if 6s. require 8s. what will 4s. require?

Answer, 5s. 4d.

Thus you see that B must sell his Shalloon in Barter at 5s. 4d. if A sell his Broad-Cloth at 8s. per Yard.

It remaineth now to find out how much Shalloon B must give for 120 Yards of Broad-Cloth, which after the same Method used to resolve the first Question of this Chapter is found to be 180, and so many Yards of Shalloon must B give A for the 120 Yards of Broad-Cloth.

Quest. 4. A and B Bartered, A had 14 C. of Sugar worth 6d. per l. for which B gave him 1 C. 3 qrs. of Cinnamon. I demand how B rated his Cinnamon per l. *Answer*, 4s. per l.

Quest. 5. A and B Barter, A hath 4 Tun of Brandy worth 37l. 16s. ready Money, but in Barter he hath 59l. 8s. per Tun. and A giveth B 21 C. 2 qrs. 11 ½l. of Ginger for his 4 Tun of Brandy, I desire to know how much B sold his Ginger in Barter per C. and how much it was worth in ready Money.

Answer For 9l. 6s. and 8d. in Barter, and it was worth 7l. per C. in ready Money.

Quest. 6. A and B Barter, A hath 320 Dozen of Candles at 4s. 6d. per Dozen, for which B giveth him 30l. in Money, and the rest in Cotton at 8d. per. l. I demand how much Cotton he must give him more than the 30l.

Answer, 11C. 1 qr.

Quest. 7. A and B Barter, A hath 608 Yards of Broad-Cloth

Cloth worth 14s. per Yard, for which B giveth him 125l. 12s. ready Money, and 8 C. 2qrs. 24l. of Bees-Wax, now I desire to know how he reckoned his Wax per C. *Answer*, 3l. 10s. per C.

CHAP. XXVIII.

Questions in Loss and Gain.

Quest. 1. A Merchant bought 436 Yards of Broad-Cloth, for 8s. 6d. per Yard, and selleth it again at 10s. 4d. per Yard, now I desire to know how much he gained in the Sale of the 436 Yards?

Answer, 39l. 19s. 4d.

First find out by the Rule of Three, or by Practice how much the Cloth cost him at 8s. 6d. per Yard, which I find to be 185l. 6s. then by the same Rule find out how much he sold it for, *viz.* 225l. 5s. 4d. then subtract 185l. 6s. which it cost him, from 225l. 5s. 4d. which he sold it for, and there remaineth 39l. 19s. 4d. for his Gain in the Sale thereof.

Otherwise, it may sooner be resolved thus, first find out how much he gained per Yard, *viz.* subtract 8s. 6d. which he gave per Yard from 10s. 4d. which he sold it for per Yard, the Remainder is 1s. 10d. for his Gains per Yard, then say.

If 1 Yard gain 1s. 10d. what will 436 Yards gain? The Answer, by Practice, or the Rule of Three is, 39l. 19s. 4d. as was found before.

Quest. 2. A Draper bought 124 Yards of Holland-Cloth, for which he gave 31l. I desire to know how he must sell it per Yard, to gain 10l. 6s. 8d. in the whole Sale of the 124 Yards? *Answer*, at 6s. 8d. per Yard.

Add the Price which is cost him, (*viz.* 31l.) to his intended Gain, (*viz.* 10l. 6s. 8d.) the Sum is 41l. 6s. 8d. then say,

If

If 124 Yards require 41l. 6s. 8d, what will 1 Yard require? By the Rule of Three. I find the Answer 6s. 8d.

Quest. 3. A Grocer bought 3C. 1qr. 14l, of Cloves, which cost him 2s 4d, per l, and sold them for 52l. 14s, I desire to know how much he gained in the whole? *Answer*, 8l. 12s.

Quest. 4. A Draper bought 86 Kersseys for 129l, I demand how he must sell them per Piece to gain 15l, in laying out 100l, at that Rate? *Answer*, 1l, 14s, 6d, per Piece? for,

As 100l, is to 115l, so is 129l, to 148l, 7s.

So that by the Proportion above, I have found how much he must receive for the 86 Kerseys to gain after the Rate of 15l, per C. then to find how he must sell them per Piece, I say,

As 86 Pieces are to 148l, 7s, so is 1 Piece to 1l, 14, 6d, which is the Rate sought.

Quest. 5. A Grocer bought $4\frac{1}{4}$C. of Pepper for 15l, 17s, 4d, and (it proving to be damnified) is willing to lose 12l, 10s, per Cent, I demand how he must sell it per Pound. *Answer*, 7d, per Pound.

Subtract 12l, 10s, the Loss of 100l, from 100l, and there remains 87l, 10s, then say,

As 100l, is to 87l, 10s, so is 15l, 17s, 4d, to 13l, 17s, 8d, so much as he must sell it all for, to lose after the Rate propounded, then to know how he must sell it per Pound, I say,

As $4\frac{1}{4}$C. is 13l, 17s, 6l, so is 1l, to 7d.

Quest. 6. A Plummer sold 10 Fodder of Lead (the Fodder containing $19\frac{1}{2}$C.) for 204l, 15s, and gained after the Rate of 12l, 10s, per 100l, I demand how much it cost him per C? *Answer*, 18s, 8d.

To resolve this Question, add, 12l, 10s, (the Gain per Cent.) to 100l, and it makes 112l, 10s, then say,

As 112l, 10, is to 100l. so is 204l, 15s, to 182l.

Which 182l. is the Sum it cost him in all, then reduce your 10 Fodders to half Hundreds, and it makes 390, then say.

As 390 half Hundreds are to 182l. so are 2 half Hundreds to 18s. 8d. the Price of 2 half Hundreds, or one Hundred Weight, and so much it stood him in per Hundred Weight.

Quest. 7. A Merchant bought 8 Tuns of Wine, which being sophisticated, he selleth for 400l. and loseth after the Rate of 12l. in receiving 100l. now I demand how much it cost him per Tun? and how he selleth it per Gallon to lose after the said Rate? *Answer*, It cost 56l. per Tun, and he must sell it at 3s. 11d. $2\frac{10}{21}$ qrs. per Gallon to lose 12l. in receiving 100l.

To resolve this Question, I consider, in the first Place, that in receiving 100l. he loseth 12l. therefore 100l. comes in for 112l. laid out, wherefore to find how much he laid out for the Whole, I say,

As 100l. is to 112l. so is 400l. to 448l. and so much the 8 Tun cost him, then to find how much it cost per Tun, I say,

As 8 is to 448l. so is 1 to 56l. the Price it cost per Tun.

Now to find how he must sell it per Gallon, reduce the 8 Tuns into Gallons they make 2016, then say,

As 2016 Gallons is to 400l. so is 1 Gallon to 3s. 11d. $2\frac{10}{21}$ qrs. the Price he must sell it at per Gallon to lose as aforesaid.

Quest. 8. A Merchant bought 8 Tuns of Wine, which being sophisticated, he is willing to sell for 400l. and loseth at that Rate 12l. in laying out 100l. upon the same, now I demand how much it cost per Tun?

Here I consider that for 100l. laid out, he receiveth but 88l. therefore to find what the 8 Tuns cost him, I say,

As 88l. is to 100l. so is 400l. to $454\frac{6}{11}$ the Price it all cost him, then to find how much per Tun, I say,

As 8 is to $454\frac{6}{11}$l. so is 1 to $56\frac{9}{11}$, or 56l. 16s. 4d. $1\frac{5}{11}$ qr. per Tun.

CHAP.

CHAP. XXIX.

Equation of Payments.

1. EQuation of Payments, it that Rule among Merchants whereby we reduce the Times for Payment of several Sums of Money, to an equated Time for the Payment of the whole Debt without Damage to Debtor or Creditor, and

The Rule is,

2. Multiply the Sums of each particular Payment by its respective Time, then add the several Products together, and their Sum divide by the total Debt, and the Quotient thence arising is the equated Time for the Payment of the whole Debt. Example,

Quest. 1. A is indebted to B in the Sum of 130 l. whereof 50 l. is to be paid at 2 Months, and 50 l. 4 Months, and the rest at 6 Months, now they agree to make one Payment of the total Sum, the Question is what the equated Time for Payment without Damage to Debtor or Creditor?

To resolve this Question I multiply each Payment by its Time, *viz.*

50 l. *multiplied by* 2 *mon. produceth*	100
50 l. *multiplied by* 4 *mon. produceth*	200
30 l. *multiplied by* 6 *mon. produceth*	180
The Sum of the Products is	480

Then I divide 480 (the Sum of the Products) by 130 (the total Debt) and the Quotient is $3\frac{9}{13}$ Months for the Time of paying the whole Debt.

Quest. 2. A Merchant hath owing him 1000 l. to be paid as followeth, *viz.* 600 l. at 4 Months, 200 l. at 6 Months, and the rest (which is 200 l. at 12 Months, and he agreeth

agreeth with his Debtor to make one Payment of the Whole, I demand the Time of Payment without Damage to Debtor or Creditor?

600 l. *multiplied by* 4 *Months is*	—	2400
200 l. *multiplied by* 6 *Months is*	—	1200
200 l. *multiplied by* 12 *Months is*	—	2400
The Sum of the Products is	—	6000

and the Sum of the Products (6000) being divided by the whole Debt (1000 l.) quotes 6 Months for the Time of Payment of the whole Debt.

The Proof of the Rule of Equation of Payments.

3. The Truth of this Rule is thus manifest, if the Interest of that Money which is paid (by the equated Time) after it is due, be equal to the Interest of that Money which (by the equated Time) is paid so much sooner than it is due at any Rate *per C.* then the Operation is true, otherwise not. Example,

In the last Question, 600 l. should have been paid at 4 Months, but it is not discharged till 6 Months that is two Months after it is due) wherefore its Interest for 2 Months at 6 *per C. per Annum* is 6 l. and then 200 l. was to be paid at 6 Months, which is the equated Time for its Payment, therefore no Interest is reckoned for it, but 200 l. should have been paid at 12 Months, but it is to be paid at 6 Months, which is 6 Months sooner than it ought, wherefore the Interest of 200 l. for 6 Months is 6 l. (accompting 6 l. *per C. per Annum*) which is equal to the Interest of 600 l for 2 Months, wherefore the Work is right.

Quest. 3. A Merchant hath owing him a certain Sum to be discharged at three equal Payments, *viz.* $\frac{1}{3}$ at 2 Months $\frac{1}{3}$ at 4 Months and $\frac{1}{3}$ at 8 Months, the Question is, what is the equated Time for the Payment of the whole Debt?

In Questions of this Nature, (*viz.* where the Debt is divided into equal or unequal Parts) each of the

Parts is to be multiplied by its Time, and the Sum of the Products is the Answer,

$\frac{1}{3}$ *Multiplied by* 2 *mon. produceth* $\frac{2}{3}$
$\frac{1}{3}$ *Multiplied by* 4 *mon. produceth* $1\frac{1}{3}$
$\frac{1}{3}$ *Multiplied by* 8 *mon. produceth* $2\frac{2}{3}$

The Sum of the Products is $4\frac{2}{3}$;

which is $4\frac{2}{3}$ Months for the equated Time of Payment.

Instead of the Fractions (representing the Parts) if you had wrought by Numbers themselves (represented by those Parts) according to the first and second Examples it would have been the same Answer, as suppose the Debt had been 90 l. then $\frac{1}{3}$ of it is 30 l. for each Payment, *viz.* at 2, 4, and 8 Months, then

30 l. *Multiplied by* 2 *mon. produceth* 60
30 l. *Multiplied by* 4 *mon. produceth* 120
30 l. *Multiplied by* 8 *mon. produceth* 240

The Sum of the Products is 420

which divided by 90 (the whole Debt) quoted $4\frac{60}{90}$, or $4\frac{2}{3}$ Months as before.

Quest. 4. A Merchant oweth a Sum of Money to be paid $\frac{1}{2}$ at 5 Months, and $\frac{1}{4}$ at 8 Months, and $\frac{1}{4}$ at 10 Months, and he agreeth with his Creditor to make one total Payment; I demand the Time, without Damage to Debtor or Creditor? Work as in the last Question, and you will find the Answer to be 7 Months.

Quest. 5. A is indebted to B 640 l. whereof he is to pay 40 l. present Money, and 350 l. at 3 Months, and the rest (*viz.* 250 l.) at 8 Months, and they agree to make an equated Time for the whole Payment; now I demand the Time?

In Questions of this Nature, (*viz.* where there is ready Money paid) you are (in multiplying) to neglect the Money that is to be paid present, and work with the Rest as is before directed, and divide the Sum

Sum of the Products by the whole Debt, and the Quote is the Answer: For here 40 l. is to be paid present, and hath no Time allowed, and according to the Rule it should be multiplied by its Time, which is (0) therefore 40 Times 0 is 0, which neither augmenteth nor diminisheth the Dividend; wherefore (to proceed according to Direction) I say,

350 by 3 Months produceth——————1050
250 by 8 Months produceth——————2000

The Sum of the Products is ——3050

which divided by 640, the whole Debt, the Quote is $4\frac{49}{64}$ Months, the Time of Payment.

Quest. 6. A is indebted to B in a certain Sum; $\frac{1}{3}$ whereof is to be paid present Money, $\frac{2}{3}$ at 6 Months, and the rest at 8 Months; now I demand the equated Time for the Payment of it all?

Answer. $3\frac{1}{3}$ Months is the Time of Payment.

Quest. 7. A is indebted to B 120 l. whereof $\frac{1}{3}$ is to be paid at 3 Months, $\frac{1}{4}$ at 6 Months, and the rest at 9 Months; what is the equated Time for the Payment of the whole Sum?

Answer. At $6\frac{1}{4}$ Months.

Quest. 8. A is indebted to B 420 l. which is due at the End of 6 Months, but A is willing to pay him 140 l. present, provided he can have the Remainder forborn so much the longer to make Satisfaction for his Kindness, which is agreed upon. I desire to know what Time ought to be allotted for the Payment of the 280 l. remaining?

To resolve this Question first, find out what is the Interest of 140l. for the Time it was paid before it was due at 6 *per Cent.* (or any other Rate) (*viz.* 6 Months) and you will find it to be 4l. 4s. Then it is evident that the remaining 280l. must be detained so much longer than 6 Months as the while it may eat out that Interest, *viz.* 4l. 4s. which is thus found out, *viz.* First, find what is the Interest of 280 l. for a Month, or any

oth

other Time; but here we will take one Month, and its Intereſt for one Month is 28 s.

Then by the Rule of Three, ſay,

As 28s. is to 1 Month; ſo is 84 s. to 3 Months; ſo that the 280 l. remaining muſt be kept 3 Months, beyond its firſt Time of Payment, (*viz.* 6 Months) which added thereto, makes 9 Months, at the End of which Time A ought to make Payment of the Remainder.

CHAP. XXX.

EXCHANGE.

1. THE Rule of Exchange informeth Merchants how to exchange Monies, Weights, or Meaſures of one Country into (or for) the Monies, Weights, or Meaſures of another Country, and when the Rate, Reaſon or Proportion betwixt the Money, Weights or Meaſures of different Countries is known, it will not be difficult for the Practitioner that is well acquainted with the Rule of Proportion (or Rule of Three) to reſolve any Queſtion wherein it is required to exchange a given Quantity of the one Kind into the ſame Value of another Kind.

2. In Queſtions of Exchange there is always a Compariſon made between the Coins, *&c.* of two Countries (or Kinds) or of more.

3. In Queſtions where there is a Compariſon made between two Things (whether they be Monies, Weights, *&c.* of different Kinds or (Countries) there may be a Solution found by a ſingle Rule of Three, as may appear by the following Example.

Queſt. 1. A Merchant at *London* delivered 370 l. *Sterling*, to receive the ſame at *Paris* in *French* Crowns; the Exchange $3\frac{1}{2}$ *French* Crowns per Pound *Sterling*. I demand how many *French* Crowns ought he to receive?

In

In placing the Numbers observe the 6th Rule of the 10th Chapter, which being done, the given Numbers will stand thus,

l. Crowns l.
1——$3\frac{1}{3}$——370

and being reduced according to the Rules of the 24th Chapter, will stand thus,

l. Crowns l. Crowns
As $\frac{1}{1}$ is to $\frac{10}{3}$ so is $\frac{370}{1}$ to $1233\frac{1}{3}$.

So that I conclude he ought to receive $1233\frac{1}{3}$ *French* Crowns at *Paris* for 370 l. delivered at *London*.

Quest. 2. A Merchant delivered at *Amsterdam* 587 l. *Flemish* to receive the Value thereof at *Naples* in Ducats; the Exchange $4\frac{4}{5}$ Ducats per l. *Flemish*. I demand how many Ducats he ought to receive?

The Proportion is as followeth.

l. Ducats l. Ducats
As $\frac{1}{1}$ is to $\frac{24}{5}$ so is $\frac{587}{1}$ to $2817\frac{3}{5}$

So I find he ought to receive $2817\frac{3}{5}$ Ducats at *Naples* for the 587 l. *Flemish* delivered at *Amsterdam*.

Quest. 3. A Merchant at *Florence* delivereth 3478 Ducatoons to receive the Value at *London* in Pence, the Exchange $53\frac{1}{2}$ Pence *Sterling* per Ducatoon; I demand how much *Sterling* he ought to receive?

The Proportion for Resolution is,

Duc. d. Duc. d.
As $\frac{1}{1}$ is to $\frac{107}{2}$ so is $\frac{3478}{1}$ to 186073

which is equal to 775 l. $6\frac{1}{12}$ for the Answer.

I might here (according to the Custom of the Arithmetical Writers) lay down Tables for the Reduction of foreign Coins to *English*; but by Reason of their Instability (for they continue not at a constant Standard as our *Sterling* Money doth, but are sometimes depressed) I shall forbear.

4. When

4. When there is a Compariſon made between more than two different Coins, Weights, or Meaſures, there ariſeth ordinarily two different Caſes from ſuch a Compariſon.

1. When it is required to know how many Pieces of the firſt Coin, Weight, or Meaſure are equal in Value to a known Number of Pieces of the laſt Coin, Weight, or Meaſure.

2. When it is required to find out how many Pieces of the laſt Coin, Weight, or Meaſure are equal in Value to a given Number of the firſt Sort of Coin, Weight, or Meaſure.

An Example of the firſt Caſe may be this, viz.

Queſt. 4. If 150 Pence at *London* are equal to 3 Ducats at *Naples*, and $4\frac{4}{5}$ Ducats at *Naples* makes $34\frac{1}{2}$ Shillings at *Bruſſels*, then how many Pence at *London* are equal to 138 Shillings at *Bruſſels* ? *Facit* 960d.

This Queſtion may be reſolved at two ſingle Rules of Three; for firſt I ſay,

If $\frac{3}{1}$ Ducats at *Naples* make 150 Pence *London*, how many Pence will $4\frac{4}{5}$ Ducats make ?

Anſwer, 240 Pence.

By the foregoing Proportion, we have diſcovered that $4\frac{4}{5}$ Ducats at *Naples* make 240 Pence at *London*, And by the Tenor of the Queſtion we ſee that $4\frac{4}{5}$ Ducats at *Venice* make $34\frac{1}{2}$ Shillings at *Bruſſels*, therefore 240d. at *London* are equal to $34\frac{1}{2}$ s. at *Bruſſels* (for the Things that are equal to one and the ſame Thing are alſo equal to one another) wherefore we have a Way laid open to give a Solution to this Queſtion by another ſingle Rule of Three, whoſe Proportion is.

As $34\frac{1}{2}$ Shillings at *Bruſſels* is to 240 Pence at *London*, ſo is 138 Shillings at *Bruſſels* to 960 Pence at *London*, which is the Anſwer to the Queſtion.

An Example of the ſecond Caſe may be this, viz.

Queſt. 5. If 40l. *Averdupois* Weight at *London* is equal to 36l. Weighs at *Amſterdam*, and 90l. at *Amſterdam* make

make 116l. at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112l. of *Averdupois* Weight at *London*.

Answer, 129$\frac{23}{25}$ Pounds at *Dantzick*.

This Question is likewise answered at two single Rules of Three *viz.* First, I say,

As 36l. at *Amsterdam* is to 40l. at *London*.

So is 90l. at *Amsterdam*, to 100l. at *London*.

And by the Question you find that 90l. at *Amsterdam* is 116l. at *Dantzick* and therefore 100l. at *London* is likewise equal thereunto, wherefore again, I say,

As 100l. at *London* is to 116l. at *Dantzick*.

So is 112l. at *London* to 129$\frac{23}{25}$l. at *Dantzick*.

By which I find that 129$\frac{23}{25}$ at *Dantzick* are equal to 112l. *Averdupois* Weight at *London*.

5. There is a more speedy way to resolve such Questions as are contained under the 2 Cases beforementioned laid down by Mr. *Kersey*, in the 3d Chapter of his Appendix to Mr. *Wingate*'s Arithmetick, where he hath given two Rules for the Solution of the Questions pertinent to the two said Cases.

6. But I shall lay down a general Rule for the Solution of both Cases; and first let the Learner observe the following Directions in placing of the given Terms, *viz.*

7. Let there be made two Columns, and in these Columns so place the given Terms one over the other, as that in the same Column there may not be found two Terms of the same Kind one with the other.

Having thus placed the Terms, the general Rule is, Observe which of the said Columns hath the most Terms placed in it, and multiply all the Terms therein continually, and place the last Product for a Dividend; then multiply the Terms in the other Column continually, and let the last Product be a Divisor, then divide the said Dividend by the said Divisor, and the Quotient thence arising is the Answer to the Question.

So the Example of the first of the said Cases being again repeated, *viz.* if 150 Pence at *London* make 9 Ducats

Ducats at *Naples* and $4\frac{4}{5}$ Ducats at *Naples* make $34\frac{1}{2}$ Shillings at *Bruſſels*. then how many Pence at *London* are equal to 138 Shillings at *Bruſſels*?

The Terms being placed according to the 7th Rule will ſtand as followeth.

	A	B	
Pence at Lond.	150	3	*Ducats at Naples.*
Ducats at Nap.	$4\frac{4}{5}$	$34\frac{1}{2}$	*Shillings at Bruſſels*
Shill. at Buſſels	138		

Having thus placed the Terms that in either Column there are not two Terms of one Kind, then obſerve that the Column under A hath moſt Terms in it, therefore they muſt be multiplied together for a Dividend; *viz.* 150 multiplied by $4\frac{4}{5}$ produceth $\frac{3600}{5}$ which multiplied by 138 produced $\frac{496800}{5}$ for a Dividend, then the Column under B, there are 3 and $34\frac{1}{2}$ which multiplied together, produce $\frac{207}{2}$ for a Diviſor; then having divided $\frac{496800}{5}$ by $\frac{207}{2}$ the Quotient is 960 Pence for the Anſwer as before.

Again, let the Example of the ſecond Caſe be again repeated, *viz.* If 40l. *Averdupois* Weight at *London* make 36l. Weight at *Amſterdam*; and 90l. at *Amſterdam* make 116l. at *Dantzick*, then how many Pounds at *Dantzick* are equal to 112l. *Averdupois* Weight at *London*.

The Terms being diſpoſed according to the 7th Rule foregoing will ſtand thus,

	A.	B.	
l. *at Lond.*	40	36	l. *at Amſterdam*
l. *at Amſt.*	90	116	l. *at Dantzick*
		112	l. *at London.*

whereby I find that the Terms under B multiplied together produce 467712 for a Dividend, and the Terms under A, *viz.* 40 and 90 produce 3600 for a Diviſor, and Diviſion being finiſhed, the Quotient giveth $129\frac{3312}{3600}$ Pounds at *Dantzick* for the Anſwer.

CHAP.

CHAP. XXXI.

Single Position.

1. NEgative Arithmetick, called the Rule of False, is that by which we find out a Truth, by Numbers invented or supposed, and this is either single or double.

2. The Rule of single Position is when at once, *viz.* by one false Position, or feigned Number, we find out the true Number sought.

3. In the single Rule of False, when you have made Choice of your Position, work it according to the Tenor of the Question, as if it were the true Number sought and if by the ordering your Position you find the Result either too much or too little, you may then find out the Number sought by this Proportion following *viz.*

As the Result of your Position is to the Position, so is the given Number to the Number sought.

Example.

Quest. 1. A Person having about him a certain Number of Crowns, said, if the fourth and third and fixth of them were added together, they would make just 45 Crowns, now I demand the Number of Crowns he had about him? *Answer*, 60 Crowns.

To resolve this Question, I suppose he had 24 Crowns (or any other Number that will admit of the like Division) now the fourth of 24 is 6, and the 3d is 8, and the fixth is 4, all which Parts (*viz.* 6, 8, and 4) being added together make but 18, but it should be 45, wherefore I say by the Rule of Three.

As 18 the Sum of the Parts is to the Position 24, so is 45 the given Number to 60 the true Number sought.

For the fourth of 60 is 15, and the third of 60 is 20, and the fixth of 60 is 10, which added together make 45.

Quest.

Quest. 2. Three Persons, *viz.* A, B, C, thus discourse together cocerning their Age, quoth B to A, I am as old, and half as old again as you, then quoth C to B, I am twice as old as you, then quoth A to them, and I am sure the Sum of all our Ages is 165, now I demand each Man's Age? *Answer*, A 30 B 45, C 90 Years of Age, which added together, make 165.

CHAP. XXXII.

Double Position.

1. THE Rule of double Position is when 2 false Positions are assumed to give a Resolution to the Question propounded.

2. When any Question is stated in double Position make such a Cross as followeth.

a X *b*
d X *c*

3. Then make Choice of any Number you think may be convenient for your working, which call your first Position, and place it at that End of the Cross at *a* then work with this Position (as if it were the true Numbet sought) according to the Nature of your Question, then having found out your Error, either too much or too little, place it on that Side the Cross at *d*, then make Choice of another Number of the same Denomination with the first Position (which call your second Position) and place it on that Side of the Cross at *b*; then work with this Position as with the Former, and having found out your Error, either too much or too little, ylace it on that Side of the Cross at *c*, and then the Positions will stand at the Top of the Cross, and the Errors at the Bottom, each under his correspondent Position, and then multiply the Errors into the

the Positions cross-wise, that is to say, Multiply the first Position by the second Error, and the second Position by the first Error, and put each Product over its Position.

4. Having proceeded so far, then consider whether the Errors were both alike, that is, whether they were both too much, or both too little, and if they are alike, then subtract the lesser Product from the greater, and set the Remainder for a Dividend, then subtract the lesser Error from the greater, and let the Remainder be a Divisor, then the Quotient arising by this Division is the Answer to the Question.

5. But if the Errors are unlike, that is, one too much, and the other too little, then add the Products of the Positions and Errors together, and their Sum shall be a Dividend, then add the Errors together, and their Sum shall be a Divisor, and the Quotient arising hence is the Answer; which two last Rules may be kept in Memory by this Verse following, *viz.*

When Errors are of unlike Kinds,
Addition *doth ensue*
But if alike, Subtraction *finds*
Dividing Work for you.

Quest. 1. A, B, and C build a House which cost 76l. of which A paid a certain Sum unknown, B paid as much as A. and 10l. over, C paid as much as A and B. now I desire to know each Man's Share in that Charge?

Having made a Cross according to the 2d Rule, I come according to the 3d Rule to make Choice of my first Position. And here I suppose A paid 6l. which I put upon the Cross as you see, then B paid 16l. (for it is said he had paid 10l. more than A) and C paid 22l. for 'tis said he paid as much as A and B, then I add their Parts.

l.		l.
6 A.		9
16 B.		19
22 C.	120 168 288	28
	6 X 9	
44 *Sum.*	12 X (14	56
	32 X 20	
76	12	76
44		56
32 *Error.*		*Error* 20

and they amount to 44, but it is said they paid 76l. wherefore it is 32 too little, which I note down at the Bottom of the Cross under its Position for the first Error.

Secondly, I suppose A paid 9l. then B paid 19l. & C 28l. all which added together, make 56 but they should make 76, wherefore the Error of this Position is 20, which I put at the Bottom of the Cross under his Position for the second Error, then I multiply the Errors and the Positions cross-wise, *viz.* 32 (the Error of the Position) by 9 (the second Position) and the Product is 288. Then I multiply 20 (the Error of the second Position) by 6 (the first Position) and the Product is 120.

Then (according to the 4th Rule) I subtract the lesser Product from the greater, (*viz.* 120 from 288, because the Errors are both alike) *viz.* too little) and there remaineth 168 for a Dividend, then I subtract 20 (the lesser Error) from 32 (the greater Error) and the Remainder is 12 for a Divisor, then divide 168 by 12. and the Quotient is 14 for the Answer, which is the Share of A in the Payment.

6. Again Secondly If the Errors had been both too big it had the same Effect, as appeareth by the following Work; for first I suppose A paid 20l. then B paid 30l. and C 30l. which in all is 100, but it should have been no more than 76, wherefore the first Error is

24

24 too much. Again, I suppose A paid 18l. then B must pay 28l. and C must pay 46l. which in all

20 A				A 18
30 B				B 28
50 C	320	112	432	C 46
	20		18	
100 *Sum*	8)		(14 *facit*	*Sum* 92
76 *Sub.*	24		16	*Sub.* 76
		8		
24 *Error*				*Error* 16

is 92l. but it should have been but 76l. wherefore the second Error is 16 too much; then I multiply 20 (the first Position) by 16 (the second Error) and the Product is 320, again I multiply 18 (the second Position) by 24 (the first Error) and the Product is 432. Then because the Errors are both too much, I subtract 320 (the lesser Product) from 432 (the greater Product) and there remaineth 112 for a Dividend, likewise I subtract 16 (the lesser Error) from 24 (the greater Error) and the Difference is 8 for a Divisor, then perform Division, and the Quotient is 14, (as before) for the Answer.

Again. Thirdly, If the Errors had been the one too big, and the other too little. Respect being had to the 5th Rule foregoing, the Answer would have been the same, as thus, I take for my first Position 6 and then the Error is 32 too little, then the Error is 32 too little, then I take for my second Position 18, and then the Error is 16 too much, then I multiply the Positions and Errors Cross-wise and the Products are 96 and 576 and because the Errors are unlike,

96	672	576
6		18
48)		(14
32		16
	48	

(*viz.*) one too big, and another too little, I add the Products, *96* and *576* together, and their Sum is *672* for a Dividend I likewise add the Errors 32 and 16 together, and their Sum is 48 for a Divisor, then having finished Division, I find the Quotient to be 14, which is the Answer as was found out at the two several Tryals before.

For Proof of the Work I say,

	l.
If *A* paid ———————————	14
Then *B* paid 14 and 10 (that is) —	24
Then *C* paid 14 and 24 (that is) —	38
The Sum of all is ———	76

which is the Total Value of the Building and equal to the given Number.

Those who desire to see the Demonstration of this Rule, let them read the 7th Chap. of Mr. *Kerseys* Appendix to *Wingate*'s Arithmetick, *Pitiscus* in the 5th Book of *Trigonometria*. Or Mr. *Oughtred* in his *Clavis Mathematicæ*.

Quest. 2. Three Persons, A. B. C. thus discoursed together concerning their Age, quoth A I am 18 Years of Age, quoth B I am as old as A and $\frac{1}{2}$ C; and quoth C I am as old as your both, if your Years were added together. Now I desire to know the Age of each Person? *Answer.* A is 18, B is 54, and C is 72 Years of Age.

Quest. 3. A Father lying at the Point of Death, left to his 3 Sons, *viz.* A. B. C. all his Estate in Money, and divided it as followeth, *viz.* to A he gave $\frac{1}{2}$ wanting 44l. to B he gave $\frac{1}{3}$ and 14l. over, and to C he gave the Remainder, which was 82l. less than the Share of B, now I demand what was the Sum left, and each Man's Part? *Answer*, The Sum bequeathed was 588l. whereof A had 250l. B had 210l. and C had 128l.

Quest. 4. Two Persons, *viz.* A and B had each in their Hands a certain Number of Crowns, and A said to B,

if you give me one of your Crowns, I shall have 5 times as many as you; and said B to him again, if you give me one of yours, then we shall each of us have an equal Number; now I demand how many Crowns had each Person? *Answer*. A had 4, and B had 2 Crowns.

Quest. 5. What Number is that unto which if I add ¼ of it self, and from the Sum substract ⅓ of it self, the Remainder will be 216? *Answer*, 192.

Many more Questions may be added, but these well understood, will be sufficient, (even for the meanest Capacity) for the Resolution of any other Question pertinent to this Rule.

There may be an Objection made because we have not treated particularly upon Interest and Rebate, but the Operation of such Questions being more applicable to Decimals, are omitted, till we come to acquaint the Learner therewith.

Laus Deo Soli.

F I N I S.

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